Jan. 29, 1964

STATEMENT BY DR. NYLE C. BRADY, DIRECTOR OF SCIENCE AND EDUCATION,
U.S. DEPARTMENT OF AGRICULTURE
Before the
SUBCOMMITTEE ON TOBACCO OF THE HOUSE COMMITTEE ON AGRICULTURE
January 29, 1964

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to appear before you to express the views of the Department of Agriculture with regard to tobacco research.

First may I make a general observation relative to research in the Department of Agriculture. Our policy has always been to do research which will provide the public with high quality agricultural products. We consider freedom from health hazards as an integral part of quality and as a consequence are concerned with the recent report on "Smoking and Health" as it relates to our research responsibilities.

Research on tobacco crops is supported by (1) Federal funds appropriated to the U.S. Department of Agriculture, (2) Federal and State funds appropriated to the twelve State Agricultural Experiment Stations and Puerto Rico, and (3) private funds allotted to research carried on in private laboratories or to support of State Station or USDA work.

The U.S. Department of Agriculture conducts comprehensive research on tobacco, including investigations of utilization and production problems. The research program is flexible, and its emphasis can be shifted as new scientific information makes it desirable to do so.

Research on tobacco constituents is conducted by Department chemists at the Eastern Utilization Research and Development laboratory at Philadelphia. This work may eventually provide a complete inventory of the dozens of organic compounds present in tobacco leaf and in tobacco smoke. Major domestic and foreign varieties are being analyzed.

Identification of these compounds and determination of their amounts in various types of tobacco will aid development of processing steps aimed at eliminating any that are not wanted. Such information will also help geneticists in planning breeding experiments to develop tobaccos that are deficient in or free of undesirable components.

The availability of sophisticated chromatographic and other recently developed equipment is helping chemists in their investigations of classes of chemicals such as hydrocarbons, fatty acids, resins, sterols and terpenes and in the identification of individual components of each class.

Laboratory investigations are supplemented by taste panel studies to determine correlation between composition and taste characteristics of tobacco. An example of a possible result of these studies is the discovery that two chemical compounds -- isovaleric acid and methylvaleric acid -- are primarily responsible for the characteristic aroma and flavor of certain premium tobaccos.

The studies on the composition of tobacco were augmented by an additional $200,000 in the appropriation bill just passed by the Congress. This will finance expanded studies of the constituents of the resins in tobacco leaf and the fate of such constituents on the burning of the leaf.

The Department's production research is aimed at aiding farmers to produce tobaccos of a quality which meets the requirements of domestic and foreign buyers and consumers and that will produce profitable yields. To attain these objectives, research is carried out on the many complex cultural, disease, and handling problems that have a direct influence on the quality and use volume of tobacco. Investigations are conducted in the various U.S. tobacco producing areas in close cooperation with twelve State Agricultural Experiment Stations.

Promising advanced breeding lines of tobacco having resistance to the important black shank fungus, root knot nematodes, and tobacco brown spot have been developed. Hybrid flue-cured and burley tobaccos are being tested.

Experiments using a new carbamate fungicide have given highly successful control of blue mold, a constant hazard to production of certain tobacco seedlings. Recent findings indicate progress toward development of plants resistant to this mold.

The effects of various fertilizer rates on tobacco quality (chemical composition) are being studied. Research on development of tobaccos having various levels of total alkaloid content is continuing.

Experiments involving use of polyethylene films and cotton cloth as coverings for plant beds are in progress as are tests of planting dates, daylength and temperature, sucker control, and cropping systems.

Research in certain phases of air pollution involving weather fleck damage to tobacco has demonstrated correlation between the appearance of weather fleck on tobacco and high values of ozone in the air.

An experimental mechanical tobacco harvester has been developed and is being modified and tested for improvement. Better methods of harvesting, handling, and curing stalk-out tobacco are also subjects of Department research.

Field scale tests of light traps for control of tobacco hornworms indicated that hornworm moth populations can be reduced by use of electric insect traps. Additional research is needed before recommendations on use of light traps can be made.

The Department has a continuing program involving basic and applied research on tobacco insects to develop effective control methods that will not lead to insecticide residue in manufactured tobacco products. This work includes more intensive investigation on lures, traps, sterilization, and other new approaches to insect control; better utilization of predators, parasites, and diseases of tobacco insects; evaluation of insect resistant tobacco varieties, and continued research for chemicals that leave no residue.

In addition, the Department conducts research dealing with the physical and biological aspects of assembling, packaging, transporting, storing, and distribution from the time the product leaves the farm until it reaches the ultimate consumer. Economic research is conducted dealing with marketing costs, margins and efficiency, economics of product quality, supply and demand and outlook and situation.

A large part of the Department's research on tobacco is cooperative with the State Experiment Stations. Cooperative work is jointly planned, frequently with the representatives of the producers or industry participating. The nature of cooperation varies with each study. It is developed so as to fully utilize the personnel and other resources of the cooperators which frequently includes resources contributed by interested producers or industry.

Including both cooperative and State Station projects, tobacco research is carried on by twelve of the fifty-three State Agricultural Experiment Stations and in Puerto Rico. The types of work to which the largest amount of effort is devoted include breeding and genetics, diseases, variety evaluation, plant culture and weed control. There is a regular exchange of information between Station and Department scientists to assure that the programs complement each other, and to eliminate all unnecessary duplication. A more detailed breakdown by location, funds, personnel and type of research conducted is attached as a supplement to this statement which clearly indicates the extent of the Department's programs on tobacco research.

As will be noted from the outline given above, the Department's research programs on tobacco to date have emphasized the quality factors and have not been directly involved with the effects of smoking on human health. However, with the release of the report of the Surgeon General of the U.S. Public Health Service entitled "Smoking and Health," Secretary Freeman believes that the Department's research should now be directed to identifying the constituents of tobacco responsible for these health problems and to finding means to reduce or eliminate them.

Research of relevance to the problems of smoking and human health is being conducted at the North Carolina, Connecticut, and Kentucky Experiment Stations. A research project at the North Carolina Experiment Station includes research on the isolation and identification of organic constituents contained in tobacco leaf, such as the aromatic carbonyls, esters, acids, alcohols, and phenols. The Surgeon General's report, "Smoking and Health," states on page 145 that "One hypothesis suggests that promoting agents present in tobacco and tobacco smoke, such as various phenols, enhance the potency of the carcinogenic hydrocarbons so as to account for the biological activity of the tobacco products."

Research at the Connecticut Experiment Station includes a study of factors affecting the distribution of phenols in harvested leaf. The role of light in the control of phenolic content of the leaf is under study, together with its effect on the metabolism of harvested leaves.

Much interest has been stirred in the role of radioactive elements in cigarette smoke as a possible factor in the genesis of bronchial cancer in smokers. The Surgeon General's report states that Polonium-210 as a source of radioactivity in cigarette smoke merits further study as a possible factor in carcinogenesis. The report further notes that there appear to be no published data on the uptake by the tobacco plant of radioactive constituents from fallout. Such constituents include Strontium 90 and Cesium 137.

Consideration is being given to expansion of research on factors affecting phenol content of tobacco leaf and to initiate further research on Polonium 210 content and on the uptake by tobacco of other radioactive elements.

Among many other conclusions, the Surgeon General's report states the following judgment: "Cigarette smoking is a health hazard of sufficient importance in the United States to warrant appropriate remedial action." Remedial action poses a problem of great difficulty since it is by no means certain at the present time what components of tobacco leaf and smoke are the responsible agents, although many chemical substances have been implicated. Nevertheless it is important that extensive investigations be undertaken to solve this problem both by chemical studies aimed at eliminating the suspected carcinogens from the smoke and through genetic, cultural, physiological, and chemical studies designed to eliminate harmful substances from the leaf. The complication involved in the problem is in part illustrated by the fact that the "pyrolosis of nontobacco cigarettes made from vegetable fibers and spinach resulted in formation of benzo(a) pyrene." /the carcinogen/ (Smoking and Health, p. 59).

Past research experience in the chemistry of tobacco serves as a sound basis for launching more extensive investigations. Work on tobacco leaf has involved studies on the isolation of acidic resins and products formed from the resins on burning. Thus far work on cigarette smoke has been concerned with a study of the volatile acids, bases, and neutral substances which may influence flavor and aroma. The composition of cigarette smoke is dependent to a large extent on the physical conditions of burning in the cigarette. Alteration of smoke components by changing the burn temperature through catalytic and other means needs to be investigated looking to the elimination of suspected carcinogens. To accomplish this, information is needed on the effect of such factors as burning temperature, leaf cut, degree of combustion, burning rate, tobacco type, etc., on the final composition of smoke. It is planned to redirect efforts along these lines. Additional investigations on the composition of the neutral resins of tobacco leaf will be conducted either under contract or through a grant arrangement. This information is essential for further studies on the possible relationship of such components to carcinogenicity of cigarette smoke.

The composition of tobacco smoke is influenced by chemical composition and physiological properties of tobacco leaf. It has been shown in Production Research conducted by the Department that tobacco leaf can be modified with respect to chemical and physiological characteristics. For example, tobacco breeding technology has reached the point that tobacco varieties with varying levels of chemical components can be developed. Cultural practices, within limits, may modify leaf components. Curing is a physiological process also influencing the chemical composition of tobacco. Basic research is needed to obtain information on resulting physiological and biochemical changes. With respect to carcinogenic materials, avenues are open through the development of new tobacco varieties and through research on physiological changes and cultural practices to reduce or eliminate these materials or their precursors.

Research of long standing in tobacco genetics and physiology provides a base on which to initiate further work in these fields related to the health hazard in smoking and additional research is being undertaken in FY-64 along these lines.

Carcinogenicity studies, when required, will be carried out in cooperation with the Department of Health, Education, and Welfare or other qualified organizations.

The experiment stations, in cooperation with medical schools, have opportunity for expanding research on reported carcinogenic, chronic respiratory and cardiovascular effects of tobacco smoke generated from various tobaccos in various forms. They can also conduct mortality and morbidity studies with laboratory animals.

The Department visualizes that in a redirected, intensive tobacco research program we would:

(1) Expand present studies on the mechanism of smoke formation and on methods to reduce or eliminate known carcinogenic related substances by altering the normal burning pattern of cigarettes and by filtering the smoke selectively.

(2) Expand present studies on the nature of the chemical substances formed on burning specific known constituents of cigarette tobacco, with special emphasis on the mode of formation of known carcinogenic and related compounds in cigarette smoke.

(3) Expand current studies to accelerate progress on the isolation and identification of chemical substances in cigarette leaf and smoke.

(4) Conduct studies on the range of variability in germ plasm with respect to components in tobacco leaf which may be precursors of carcinogenic substances in smoke.

(5) Expand present studies on the nature of the inheritance of genetic factors in the tobacco plant which control leaf composition with the object of eliminating or reducing carcinogenic precursors.

(6) Initiate investigations on tobacco to reduce or eliminate carcinogenic precursors through studies on breeding, physiological changes, and cultural practices.

(7) Initiate studies on chemical, physical, and biochemical means of reducing or eliminating carcinogenic precursors from tobacco leaf.

(8) Determine the influence of cultural and other treatments on radioactive components of tobacco suspected of being carcinogenic.

The research program of the Department would be greatly benefitted by the establishment of a laboratory for the purpose of conducting investigations on tobacco and tobacco products. The studies would be designed to ascertain and emphasize those quality and other factors which will preserve the desirable characteristics of tobacco and tobacco products and eliminate therefrom any characteristics which may be detrimental to health. Reasons for this are:

(1) The report "Smoking and Health" has indicated that the smoking of tobacco is or can be detrimental to health.

(2) The chemical constituents of tobacco that are responsible for the reported carcinogenicity of the smoke are incompletely known as is also the mechanism by which they may be converted to carcinogens. Such information must be developed and applied through intensified chemical, genetic, processing and related research before practical procedures can be developed for eliminating the characteristics of tobacco that may be detrimental to health.

(3) The problem is a complex and difficult one. A concerted effort by a team of highly-trained specialists -- geneticists, agronomists, chemists, physiologists, pharmacologists, physicists, fermentologists -- working together in a fully adequate facility, and in cooperation with Federal and State research groups, represents the best way to mount an effective assault on the many phases of this problem and to provide leadership for a meaningful supplementary research contract and grant program.

(4) The Agricultural Research Service and the State Agricultural Experiment Stations have developed considerable information in this field and have the necessary nucleus of capable research personnel and leadership upon which an effective expanded program can be built. They plan to intensify research to the extent present space and facilities will permit. By the time the proposed laboratory becomes operable, ARS would be in position to fully prosecute the research and development program required to yield meaningful results within a reasonable period.

(5) A new laboratory could also provide facilities for scientists from cooperating Federal research agencies, including the Department of Health, Education, and Welfare and the Atomic Energy Commission.

The Department is moving ahead in making contact with representatives of the Department of Health, Education, and Welfare to make certain that our efforts will be coordinated with theirs. We have also taken steps to reorient our own research program.

Gentlemen, I appreciate the opportunity to discuss the Department's research program with you, and if there are questions, I shall try to answer them.

SUPPLEMENT TO STATEMENT BY DR. NYLE C. BRADY, DIRECTOR OF SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE
BEFORE THE SUBCOMMITTEE ON TOBACCO OF THE HOUSE COMMITTEE ON AGRICULTURE
JANUARY 29, 1964

SUMMARY OF FUNDS - TOBACCO RESEARCH

Type of Research	Fiscal Year 1964
FEDERAL FUNDS:	
USDA Agencies	
Production	$1,514,200
Utilization	276,500
Marketing and Economic	168,600
Federal Grant Funds to States	
Production	337,121
Marketing	82,151
TOTAL FEDERAL FUNDS	$2,378,572
NON-FEDERAL FUNDS at State Experiment Stations	
Production	328,609
Marketing	31,430
TOTAL NON-FEDERAL FUNDS	$360,039
GRAND TOTAL FUNDS - TOBACCO RESEARCH	$2,738,611

UNITED STATES DEPARTMENT OF AGRICULTURE

Estimated Obligations for Research on Tobacco, Fiscal Year 1964

Summary

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds a/	Professional	Other	Total
PRODUCTION RESEARCH:				
Agricultural Research Service:				
Crops--production breeding, quality, and disease investigation; weeds; nematodes; plant disease reporting and mycology; plant introduction; and all other crops research	$1,112,300	32.5	37.2	69.7
Entomology--entomological studies of tobacco insects; insect identification; and pesticide residues research	195,600	6.9	7.1	14.0
Agricultural Engineering--mechanical harvesting of tobacco and other engineering studies	182,300	6.8	.8	7.6
Total, Agricultural Research Service	1,490,200	46.2	45.1	91.3
Economic Research Service:				
Farm economics research	24,000	1.0	1.2	2.2
TOTAL, PRODUCTION RESEARCH	1,514,200 b/	47.2	46.3	93.5
UTILIZATION RESEARCH AND DEVELOPMENT:				
Agricultural Research Service:				
Investigations of chemical constituent of tobacco and tobacco smoke in relation to quality improvement (East)	276,500	9.1	7.9	17.0

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds a/	Professional	Other	Total
MARKETING RESEARCH:				
Agricultural Marketing Service:				
Marketing quality research	$72,700	4.0	1.0	5.0
Economic Research Service:				
Marketing economics and economic and statistical analyses	80,300	3.0	4.4	7.4
Farmer Cooperative Service:				
Strengthening farmer cooperatives	15,600	.7	.5	1.2
TOTAL, MARKETING RESEARCH	168,600	7.7	5.9	13.6
TOTAL, TOBACCO RESEARCH	1,959,300 b/	64.0	60.1	124.1

a/ Does not include amounts that may become available under transfers from Commodity Credit Corporation for utilization and cost of production research.

b/ Excludes allocation of $65,000 from the Contingency Research Fund for more extensive research on tobacco sucker suppressants.

Detail by Location

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds	Professional	Other	Total
PRODUCTION RESEARCH:				
Florida, Quincy:				
Entomological studies on tobacco insects	$14,600	--	.1	.1
Georgia, Tifton:				
Agronomy, pathology, and physiology of flue-cured tobacco ($43,300); control of nematodes in tobacco by use of chemicals and through crop rotation ($6,600)	49,900	3.0	1.0	4.0
Kentucky, Lexington:				
Agronomy and breeding of burley and dark‖fired tobacco ($133,400), and basic physiological research on tobacco ($106,700); harvesting and curing of tobacco ($86,600)	326,700	8.0	7.0	15.0
Maryland:				
Beltsville				
Basic research on tobacco genetics, diseases, alkaloid composition, and physiological and air pollution research ($235,300); evaluation of herbicides and formulations for weed control in tobacco ($3,100); identification and taxonomy of organisms affecting tobacco ($12,500); persistence and degradation of pesticides in plants and soils ($1,300); introduction and sanitary inspection of tobacco germ plasm from foreign countries ($2,500); pesticide residue studies ($31,800); printing, biometrics, and other centralized administrative services located at Beltsville, Md., Washington, D. C., and the four field administrative divisions ($218,000)	504,500	12.0	14.3	26.3

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds	Professional	Other	Total
Maryland - Continued				
Upper Marlboro				
Production, breeding and diseases of Maryland-type tobacco	$12,100	.5	.5	1.0
Total, Maryland	516,600	12.5	14.8	27.3
New Jersey, Moorestown:				
Identification of tobacco insects	300	--	--	--
North Carolina:				
Oxford				
Agronomy, breeding and pathology of flue-cured tobacco ($181,000); entomological studies on tobacco insects ($55,000); research on tobacco insects through light traps ($16,600) and planning and cultivating practices in growing tobacco ($24,900)	277,500	8.0	8.2	16.2
Raleigh				
Basic physiological research on tobacco ($14,800) and developing procedures for accurately forecasting outbreaks of tobacco blue mold ($3,400)	18,200	2.0	--	2.0
Waynesville				
Agronomy, disease and breeding of burley tobacco	16,100	1.0	--	1.0
Total, North Carolina	311,800	11.0	8.2	19.2
Pennsylvania, Landisville:				
Agronomy and breeding of cigar tobacco	11,600	1.0	1.2	2.2
South Carolina, Florence:				
Breeding and pathology of flue-cured tobacco ($50,400) and entomological studies on tobacco insects ($33,000)	83,400	4.0	6.6	10.6

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds	Professional	Other	Total
Tennessee:				
Greeneville				
Agronomy, breeding and pathology of burley tobacco	$80,300	4.0	3.0	7.0
Knoxville				
Physiological investigations on burley tobacco	16,200	--	1.0	1.0
Springfield				
Testing of dark-fired tobacco	1,500	--	--	--
Total, Tennessee	98,000	4.0	4.0	8.0
Texas, Brownsville:				
Entomological studies on tobacco insects ($1,300) and identification of tobacco insects ($200)	1,500	.3	.7	1.0
Virginia, Blacksburg:				
Testing advanced lines of tobacco ($1,600) and electric light traps for survey and control of tobacco insects ($23,000)	24,600	.8	.8	1.6
Wisconsin, Madison:				
Breeding and pathology of cigar tobacco	14,300	1.0	.5	1.5
Puerto Rico, Mayaguez:				
Breeding, disease, and physiological research on burley and flue-cured tobacco--(Winter-testing) .	21,200	--	--	--
Washington, D. C.:				
Identification of tobacco insects ($15,700) and economic analysis of alternative adjustment on tobacco farms, and of annual changes in investments, costs, and income of farms ($24,000)	39,700	1.6	1.4	3.0

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds	Professional	Other	Total
TOTAL, PRODUCTION RESEARCH	$1,514,200	47.2	46.3	93.5
UTILIZATION RESEARCH AND DEVELOPMENT:				
Pennsylvania, Wyndmoor: Chemical investigations to provide basic information for development of improved quality and extended utilization of tobacco	250,300	9.1	7.9	17.0
Washington, D. C.: Printing, biometrics, and other centralized administrative services located at Washington, D. C., Beltsville, Md., and the four field administrative divisions	26,200	--	--	--
TOTAL, UTILIZATION RESEARCH AND DEVELOPMENT ...	276,500	9.1	7.9	17.0
MARKETING RESEARCH:				
Georgia, Savannah: Basic studies on insecticide evaluation to develop better insect control methods in stored tobacco .	14,000	1.0	--	1.0
Virginia, Richmond: Methods to prevent insect damage during longtime storage in tobacco warehouses, including studies on the ecology of stored tobacco insects	48,000	3.0	1.0	4.0
Washington, D. C.: Tobacco quality and pricing system, the organization, costs and efficiency of tobacco redrying plants; marketing margins and costs for tobacco leaf and products; costs and efficiency of looseleaf tobacco				

UNITED STATES DEPARTMENT OF AGRICULTURE
Cooperative State Research Service

Estimated Obligations for Research on Tobacco, Federal-grant and Non-Federal Funds, Fiscal Year 1964

SUMMARY

	1964 Federal-grant	1964 Non-Federal
Production Research	$337,121	$328,609
Marketing Research	82,151	31,430
Total	419,272	360,039

DETAIL BY STATES

	Production Research		Marketing Research	
	Federal-grant	Non-Federal	Federal-grant	Non-Federal
CONNECTICUT				
Breeding, genetics, mechanical harvesting, and quality	$13,000	$13,500	$30,500	$24,000
FLORIDA				
Breeding, culture, mechanical harvesting, and insect control	22,076	30,000	--	--
KENTUCKY				
Breeding, genetics, disease control, culture, mechanical harvesting, insect control, quality, and marketing	95,580	101,519	17,536	1,215
MARYLAND				
Breeding and culture	2,920	14,730	4,000	4,000
NORTH CAROLINA				
Genetics, disease control, culture, mechanical harvesting, insect control, quality, economics, and marketing	83,811	95,525	26,536	2,015
PENNSYLVANIA				
Culture and marketing	940	11,035	3,579	200

	Fiscal Year 1964			
		Estimated Program Man-Years		
	Funds	Professional	Other	Total
Washington, D. C. - Continued				
auctions; study of Canadian tobacco auctions ($20,700); programs of economic and statistical research and service work related to tobacco ($59,600); related program planning, technical direction and supervision, development and publication of reports on research results and other management and supporting services ($10,700); and strengthening of farmer cooperatives ($15,600)	$106,600	3.7	4.9	8.6
TOTAL, MARKETING RESEARCH	168,600	7.7	5.9	13.6
TOTAL, TOBACCO RESEARCH	1,959,300	64.0	60.1	124.1

	Production Research		Marketing Research	
	Federal-grant	Non-Federal	Federal-grant	Non-Federal
PUERTO RICO				
Breeding, culture, insect control, and economics	$40,538	$29,100	--	--
SOUTH CAROLINA				
Culture	6,356	1,200	--	--
TENNESSEE				
Breeding, disease control, and culture	19,000	4,000	--	--
VIRGINIA				
Breeding, disease control, culture, and insect control	37,000	28,000	--	--
WEST VIRGINIA				
Culture	15,900	--	--	--
TOTAL	337,121	328,609	82,151	31,430

DESCRIPTION OF PROGRAMS

Breeding
Breeding tobacco for improved resistance to diseases and nematodes and acceptable quality. (Connecticut, Florida, Kentucky, Maryland, Puerto Rico, Tennessee, and Virginia)

Genetics
Fundamental studies of genetics of tobacco are being made. The work involves interspecific hybridization, the determination of mechanisms for transfer of heritable disease resistance between species, inheritance of biochemical mechanisms, and the development of basic genetic stocks for varietal improvement. (Connecticut, Kentucky, and North Carolina)

Disease Control
Disease of the leaf, root rots, nematodes, and viruses are receiving attention. In addition, most of the breeding effort is oriented toward resistance to disease. Other areas of tobacco disease study include root rot complexes, mode of action of fumigants and nematocides and nematode population dynamics. (Kentucky, North Carolina, Tennessee, and Virginia)

<u>Culture</u>
The States are determining the effects of plantbed practices, planting methods, spacing, crop rotations, fertilizer practices, sucker control, topping and curing on the yield and quality of tobacco. All types of tobacco are involved. (Florida, Kentucky, Maryland, Pennsylvania, Puerto Rico, South Carolina, Tennessee, Virginia, and West Virginia)

<u>Mechanical Harvesting</u>
Developing methods of harvesting tobacco mechanically. Modifications of and a better basic understanding of the curing process are under study. (Connecticut, Florida, Kentucky, and North Carolina)

<u>Insect Control</u>
Work in this area includes basic biology and physiology, insecticidal and cultural control, insecticide residues, biological control and varietal resistance to insects. (Florida, Kentucky, North Carolina, Puerto Rico, and Virginia)

<u>Quality</u>
Work includes chemical composition and physical properties of leaf, chemical composition of smoke, and new and improved processing technology. (Connecticut, Kentucky, and North Carolina)

<u>Farm Economics</u>
The study of production economics. Price research to meet the needs of farmers, labor availability and other production and harvesting costs are receiving attention. (North Carolina and Puerto Rico)

<u>Marketing</u>
Projects in this area deal with factors affecting the dispersion in prices, tobacco auction, warehouses, alternative parity formulas, market potential in Egypt, labor requirements in marketing, and market structure. (Kentucky, North Carolina, and Puerto Rico)

CONTINUING OPPORTUNITIES FOR COOPERATION IN AGRICULTURAL RESEARCH

Talk by Dr. Nyle C. Brady, Director of Science and Education, U.S. Department of Agriculture, at dedication of Biological Sciences Building, University of Illinois, Urbana, Illinois, March 6, 1964.

Science and education are, today, the magic words to a better and more meaningful life.

We in this country have rapidly developed and implemented scientific knowledge as a matter of national policy. The results are apparent all around us -- improved health, comfort, and security, longer life, greater leisure, and an abundance of food -- things that are still only a dream in most parts of the world.

American agriculture in particular has demonstrated the effectiveness of using science and education as tools in man's struggle for a decent existence. Our success in producing basic food and fiber needs has, in fact, set the stage for development of other parts of our economy.

Now that we have achieved success, it would be pleasant to relax and coast along on what the State land-grant colleges and the Department of Agriculture have so far accomplished in their brief existence of little more than a century.

But the onward rush of change is so compelling, so swift and sure, that much of what we develop today is outdated in only a few years' time. It is vitally important that we understand this worldwide drive for change and anticipate it . . . that we continuously adjust our thinking and our mechanisms for research and education to make them more responsive to the newer needs of our people.

We in the Department of Agriculture are determined to do everything humanly possible to increase and strengthen agricultural research for the job ahead. We have already moved in several directions to strengthen opportunities for cooperative work.

For example, under the provisions of recently passed legislation, we now have the authority to encourage and assist the States in carrying out a program of cooperative forestry research. The McIntire-Stennis Act -- Public Law 87-788 -- recognizes research in forestry as a definite and specific part of publicly-supported agricultural research.

It has become increasingly clear that we need much more basic information and many new technological advances before we can increase the efficiency of forest and rangeland management practices for the production of more and better timber, grazing, wildlife, water, and recreation.

We feel that the intensified, far-reaching cooperative research that will be conducted under the McIntire-Stennis Act will enable us to produce this information and make these advances. It will also help to stimulate the training of forestry scientists, who will be needed in increasing numbers if our resources development is to have a sound foundation.

The work will be carried out in the land-grant universities and other qualified State-supported institutions, with support from Federal grants and matching State funds. Additional appropriations will be provided from time to time as Congress deems necessary.

The Secretary of Agriculture will be working closely with a national advisory board consisting of officials of forestry schools -- officials, by the way, selected by the schools themselves. The Secretary will also have the help of an advisory committee -- appointed by him -- made up of representatives of State, Federal, and private agencies.

The research to be conducted under this Act will benefit all Americans who look to the Nation's parks, streams, and out-door areas for their mental and physical relaxation. We hope to be able to preserve the beauty and richness of our country's natural resources for the benefit and enjoyment of future generations, as well as ourselves.

In addition to the McIntire-Stennis Act to promote forestry research, there is another piece of legislation that will give the Department and the States an opportunity to work together. That is the Abernathy Bill -- Public Law 88-74 -- which provides for the construction of badly-needed research facilities.

This law gives us the authority to administer Federal-grant funds to the States to help finance the laboratories and equipment needed to carry on good research. The States will match Federal funds for construction of these facilities.

As you may know, most of the work of the State experiment stations and the Department of Agriculture is carried out jointly -- at least half of it on a formal basis and the rest on an informal basis. Consequently, whatever obligations are placed on agricultural research are obligations upon the entire Federal and State structure. And whatever can be done to provide adequate research facilities for State scientists obviously will benefit Federal scientists, too.

This action is in keeping with a recommendation made by the Life Sciences Panel of the President's Science Advisory Committee in the recent report on science and agriculture. It is also in keeping with a similar recommendation made by the Committee on Agricultural Science -- a group of 15 of the Nation's distinguished scientists appointed by the Secretary to conduct a continuing evaluation of publicly-supported agricultural research.

We are glad to have the assistance of a special State-Federal Review Team, appointed by the Secretary last year to evaluate the research facility needs of the States, the Department, and of various regions. The work of this group in defining needs and establishing priorities will be a great help in coordinating the total agricultural effort more closely and will assist us in locating research where it can be done most efficiently.

This kind of joint planning by the States and the Federal Government from the very earliest stages should make it possible to develop a network of first-rate publicly-supported research centers we can all be proud of. We can expect many significant scientific contributions from these centers.

Another opportunity for closer cooperation between the States and the Department of Agriculture and for broadening our horizons in agricultural research is through a new competitive grant program in support of basic research.

Funds have been made available for fiscal year 1964 for grants to the State agricultural experiment stations for fundamental studies on certain commodities.

We are especially pleased with this opportunity as it opens up a new challenge in the conduct of research. It will give the States increased responsibility for doing basic research in areas where they have highly-qualified scientists. We are confident the work will produce results that can help us solve some of agriculture's most persistent problems -- how to lower the costs of production, for example.

We intend to set up several committees of scientists in certain subject-matter fields -- such as physiology of weed control and crop plant genetics, for example -- to consider the merit of the proposals and the special competence of the people to do the work. The studies must be basic, of course, and in an area where grant funds are available.

The committees will consist of two scientists from the State agricultural experiment stations or land-grant schools, two from the Agricultural Research Service, and one from the Cooperative State Research Service. This kind of evaluation should bring about greater coordination of efforts and insure a closer working relationship between the States and Department agencies doing similar work.

At the present time, the money for these grants is based on a special transfer of funds authorized by Congress for one year only, although research proposals covering two or three years will be supported by the initial authorization. Even in only a year's time, however, we feel the work can demonstrate the value of awarding grants on a competitive basis.

Here is one way, it seems to me, that we could strengthen agricultural research and advance knowledge across the whole front of the natural and social sciences. Let me elaborate a bit.

There are two basic methods of administering research funds in the Federal Government.

The traditional method -- the one that is used by the Department of Agriculture and the land-grant colleges -- is characterized by administrative control of both the budget and the program.

For example, under the Hatch Act of 1887, the Department administers Federal-grant funds for research by the State experiment stations. These funds are given to institutions with no particular emphasis on the individual scientists. The money is distributed largely in accordance with a formula based on the State's rural and farm population. In addition, a sizable part of the Hatch-Act funds are used to support regional studies, with area problems the main factor in determining how and where the money is spent.

This kind of grant assures a broad geographic distribution of research support. It is a highly democratic way to distribute grant money, and funds can be accounted for at all times. Furthermore, the research is generally done where the public wants it. And the continuity of funds permits long-term planning.

On the other hand, working scientists often have less to say in the planning of the research budget or program than, in my opinion is desired. In some cases there is too little emphasis on individual competence in granting the funds. And it's possible that basic research does not get all the emphasis it deserves.

The other method of administering research funds is one that has sprung up since World War II, and is extensively used by such granting agencies as the National Science Foundation, the National Institutes of Health, and the Atomic Energy Commission.

Research under this method is largely scientist-oriented and controlled, and grants are given primarily on the basis of individual competence. There is considerable competition for grant funds of this type, with scientists both in and outside the granting agencies making the final selection of the recipients.

Such grants promote academic freedom because the scientist largely controls his own program. Funds are presumably concentrated in areas where the best scientists are located. Basic investigations get good support. And there is ample opportunity for making changes in the work once it gets underway.

A system like this, however, can focus attention on the individual scientist to the exclusion of any real interest in coordinating a total research program. Frequently, the university administration has assumed little authority over the work. In some cases the scientist has left the institution and has taken his projects and grant money with him to another location. The institution has become merely a holding company for a group of independent scientists each with his own little "kingdom." Then, too, the fact that funds are not provided on a regular sustaining basis does not encourage long-term planning.

I would like to see the Department of Agriculture utilize a system of grants that combines the advantages of both the types I have outlined.

We will, of course, continue to allocate some grant funds to the States on a formula system -- hopefully much more than we have in the past. And we will continue to support a strong research effort in the Department -- one that is largely problem-oriented.

I believe we should also expand our grant program by awarding more money for the work of individual scientists with the awards being made on a competitive basis. We should continue to give grants to institutions -- and should expect university administrators to assume responsibility for their expenditure. But the competence of individual scientists and the quality of the project proposals should be the major consideration in deciding which projects get the funds. In short, I believe the total operation of research programs is a joint function of the administrator and the scientist -- not the sole responsibility of either.

Grants of this type would give us the flexibility we need in attacking some of the deep-seated problems of agriculture. These grants would give scientists a greater voice in planning and carrying out the work, thus contributing to their individual growth and giving them a little more freedom to follow through with their own ideas.

Incidentally, the proposal to direct our grants more to the individual scientist is in line with recommendations recently made by the Life Sciences Panel.

This group has also recommended another course of action which would increase the opportunities for cooperation between the States and the Department of Agriculture. Members of the Panel suggested that the opportunities for scientific growth and achievement by agricultural scientists should be increased and improved. There's much we can do in this respect.

I believe that we could work out a plan for rotating some of our scientists in the field into some of the Nation's land-grant and other universities for work and study. In a sense, this would provide some of the advantages of the university system of granting sabbatical leaves for intellectual growth.

This is not a novel idea. It is simply an extension of existing practices and philosophies underlying our dispersed national agricultural research system.

USDA already has many of its people working at land-grant universities. We have about 2,300 employees working on college campuses and at State-owned field stations, and spend about $20 million at these locations. Right here in Illinois, for example, at the agricultural experiment station, 26 Department employees are working cooperatively on many projects with the State people.

I believe there would be considerable merit in moving more of our scientists into such centers of research and education for brief periods of time. The scientists would bring their experience and background to bear on work at the schools. Moving a man, say, from North Dakota to Illinois, with the varying agricultural problems of these States, would be certain to bring fresh ideas and concepts into any mutually-conducted work.

The scientists, of course, would be encouraged to take some course work and would have the opportunity to bring themselves up to date on the latest developments in their fields. From work such as this and from the association with other scientists, the individual scientist would return to his own organization with a broader background and would do a better job.

Actually, we already have the authority to send our young men and women to universities for a year's advanced study. The Government Employees Training Act of 1958 permits us to pay their travel expenses, tuition, and salary, provided the course work taken eventually benefits the Government.

The legislation itself is broad, but there are some practical limitations. For example, all the expenses must come out of the operating budget of the organization, which means that all aspects of the research must be carefully balanced against the merits of advanced study. Moreover, the number of employees who can receive full-time schooling under this Act is limited to 1 percent of the total number of employees in the Department.

Even so, in fiscal year 1963, 40 percent of all employees in the Agricultural Research Service took some kind of service training, financed under the Government Employees Training Act, at a cost of $1 million.

The Department also contributes in other ways toward training scientific manpower. It supports 25 research associateships to enable some of the Nation's promising young scientists to do a year's work in our pioneering research laboratories -- which have been established to conduct creative exploratory investigations into broad scientific areas.

We also provide fellowships and traineeships at various levels of study, employ graduate assistants for research, sponsor scientific courses, and generally encourage employees to take leave for further study on their own.

Useful as this is, it is only a small part of what we can do to increase the opportunities for scientists to keep current with the newest and best that science has to offer . . . to stir up their imaginations through the stimulating crossfire offered by scientists at other institutions. Whatever they gain in knowledge, background, and experience is eventually shared by all of us in terms of better living.

In summary, the opportunities I have stressed for improving State-Federal cooperation . . . through forestry research . . . construction of new research facilities . . . competitive grants . . . and personnel exchange . . . all of these will inevitably help us to build a strong, closely interwoven agricultural research program capable of withstanding the pressures of profound change, growing population, and international tensions.

With pressures like these facing us daily, it is not a luxury to insist on all possible improvements in our national research effort. It is a matter of utmost necessity.

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For Release Only by the Senate
Committee on Appropriations.

UNITED STATES DEPARTMENT OF AGRICULTURE

Statement of Nyle C. Brady, Director of Science and Education, U. S. Department of Agriculture, before the Senate Subcommittee on Appropriations for the Department of Agriculture and Related Agencies, and Farm Credit Administration, July 21, 1964

Mr. Chairman and members of the Committee.

We face a pesticide dilemma. We cannot live without them. And we're finding it more and more difficult to live with them. On the one hand these chemicals are giving us greater protection from pests than we've ever known. On the other hand, they present a potential problem of environmental contamination which must be considered.

Organic pesticides have proliferated during the two decades since the advent of DDT. Today, there are more than 57,000 different formulations registered by the Department under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act.

These pesticides serve to make our farmers the most efficient in the world; they protect the quality and wholesomeness of farm products and they help maintain this quality through marketing channels and into retail stores.

They are our chief weapons in fighting alien pests newly established in this country. They help protect the beauty and timber potential of our forests. Pesticides provide the only effective means for controlling most epidemic insect losses to our forests.

Pesticides are equally important tools of public health officials in their continuing fight against pest-borne diseases. In fact, they have become the everyday tools of most all of us.

THE QUALITY OF AGRICULTURAL RESEARCH

Talk by Dr. Nyle C. Brady, Director of Science and Education, U. S. Department of Agriculture, before Agricultural Research Institute, Washington, D. C., October 12, 1964

The scientific revolution that began in this country about 25 years ago is evolving into three phases of development. The first was the phase of rapid scientific growth and development. The second is one of critical research evaluation. And we can see the third phase coming up . . . in meeting the need for changes made apparent by our evaluation.

At the beginning of the scientific revolution, about 1940, the Federal government began a crash program of research to meet the emergency needs of World War II. The best scientists, wherever they could be found, were pressed into service on almost a round-the-clock basis. The results of this all-out national effort opened -- almost simultaneously -- countless doors to new scientific knowledge. And at the war's end, this knowledge was released for peacetime use.

The wealth of material . . . made suddenly available . . . stimulated and compelled the inquisitive minds of scientists in research laboratories all over the country to dig deeper into the unknown . . . and to solve more of our most pressing and immediate needs. With the new research tools, scientists of the various disciplines continued to move rapidly forward in many different directions.

This first phase was one of wonderment and awe at the incredible progress the mind of man can achieve. The principal interest was in more and more research achievement by expanding efforts.

As an illustration of this point: In 1940 the Federal government was spending a little over $74 million on all research. During fiscal year 1964, Federal research appropriations amounted to about $15 billion. Even if we made the necessary adjustment in dollar values for proper comparison, these funds still demonstrate the markedly increased emphasis on research.

Agricultural research did not expand proportionately with the whole. In 1940 the funds for agricultural research made up 40 pcercent of the Federal research budget. In fiscal year 1964 these funds were only 1.3 percent of the research budget. The necessary large expenditures for such new research efforts as the programs in defense and space travel explain in part the comparative reduction in emphasis on agriculture.

However, the $326 million Federal appropriation for agricultural research in fiscal sixty-four is more than 10 times the amount in 1940. States, too, are increasing support for agricultural research, with a combined total of $140 million during 1964. Industry is adding an estimated $400 million a year for research and development in agriculture.

We still have not gone as far or as fast as we would like in many parts of a total agricultural research program. We need much more intensive work if we are to be in a position to meet some of our immediate problems, to solve those that we foresee for the future, and to meet the unexpected problems that may call for sudden attention.

But agricultural research has expanded to the extent that increased support has permitted. We have been a part of the first phase in the scientific revolution, which has been a vitally important and necessary beginning. We have passed into the second phase, along with the rest of the Nation's scientific community.

During this second phase, the wonder of scientific progress is being replaced by questions concerning quality of the work . . . particularly in agricultural research. In fact, the voice of the critic has been heard and is being heard on this subject.

Of course, analyses of research programs have always been a part of administrative responsibility. This responsibility is constantly met through the use of judgments and decisions. Frequent studies and surveys have been made over the years to check on the possible need for shifts of emphasis to meet changing trends. The responsibility for administrative judgment has been met successfully in agricultural research. The outstanding progress of our agriculture is one proof of that point.

However, the questions now being raised concern the quality of agricultural research today. They deal with what we are doing, and how we are doing it. Are we making the best use of our current resources? What are we doing to protect and improve our future potential?

In this period of critical evaluation, claims have been made that agricultural research is inferior to other publicly supported research.

Some critics claim that the environment for scientists in the U. S. Department of Agriculture is not good. Too many are located at small stations. Claims are made that USDA scientists are not sufficiently trained when they come on the job, and that we give them no opportunity and encouragement for retraining while they are working. Some critics claim that we do not encourage creativity, but try to fit all scientists into a mold . . . that the support per scientist is inadequate in USDA. They claim that we do not make good use of some of our better scientists and that research in the Department is not well coordinated.

Let's just look at the quality of research in USDA today, and see what is being done to prepare for the future.

What about the claim that the environment for good quality research is inadequate . . . that too many of our scientists are located in isolated communities?

These are the facts:

At the beginning of 1964, we had a total of 5,303 professional employees engaged in research. Of this number, 27.3 percent were located here in the Washington and Beltsville area. Another 51.9 percent were in university communities; 10.4 percent were in other type communities in which there were 15 or more agricultural scientists; 5.8 percent were in communities with from 5 to 14 agricultural scientists; and 3.5 percent were in communities with less than 5 agricultural scientists. The remainder, 1.1 percent, were in Puerto Rico, the Virgin Islands, and foreign countries.

Thus we see that 89.2 percent of our scientists are located in the Washington and Beltsville area or in university communities. Only 3.5 percent were at stations with fewer than 5 agricultural scientists.

During the past five years we have closed out 72 of these small stations having fewer than 5 scientists.

We are experiencing some difficulties in attempts to locate department research facilities on or near university campuses. The universities have campus space problems, and in their longterm plans hesitate to allocate scarce land resources for department research facilities. Even so, we are still continuing efforts to relocate our scientists on university campuses and in other environments where they will have better opportunities for exchange of ideas.

What about the criticism that creativity is not encouraged among USDA scientists? That would be a serious handicap to a satisfactory scientific environment -- if true.

We wanted to know the answer to this and many other questions. To that end, Secretary of Agriculture Freeman in a memorandum dated April 14, 1964, established a Departmental interagency task force to study the training and the scientific environment of the Department's research and education personnel. This was a carefully planned and executed survey to determine a wide variety of precise information.

On the question of creativity, the survey showed a high degree of satisfaction among scientists with the freedom they have to plan and execute their own work. However, we did find some soft spots in the opportunities for individual initiative, and we intend to locate all these spots wherever they may be. A lack of proper direction and supervision may be at fault in some cases . . . in others it may be over-direction. We firmly intend to take whatever steps are necessary to improve the areas where the environment for creativity may not measure up to the high standards already being set.

Let's look at the claim that our scientists are not well trained for the job. Of the total professional employees engaged in the Department's research programs, 34.8 percent hold doctorates. Another 34.2 percent hold master's degrees. That compares to 72 percent holding Ph. D. degrees among scientists and engineers employed in all colleges and universities. That is not an unfavorable comparison when you realize the wide range of activities the Department's professional employees carry out in our research programs. Much of the work does not require the highest degrees for competent beginners. On the other hand, some of the work requires the most intensive education and training that can possibly be brought to the job. In colleges and universities, the requirements for training are on a much more consistent level.

This varying of requirements can be illustrated by looking at the Agricultural Research Service. This agency has a total of 3,480 professional employees. Of these 39.5 -- or almost 40 percent -- hold doctor's degrees. This breaks down as follows: In Farm Research, 46.2 percent; in Utilization Research and Development, 31 percent; in Nutrition and Consumer Use Research, 24.1 percent; in Marketing Research, 23 percent; and in Foreign Training Programs and in Administration, 41.8 percent.

More careful evaluation within the agency shows differences that cannot be explained easily. For example, in Farm Research one division has 68.4 percent Ph. D.'s, while another with a very similar mission has only 37.6 percent. We expect to determine the reasons for these differences and to take steps to improve the academic training in all cases where it is justified.

But initial training and education are not enough. What about the opportunity for training and retraining to meet present and future needs? Growth in professional competence is increasingly important to meet the exacting demands of research problems that are becoming more and more complex. Where there is a continuous and adequate training program, with full participation, all personnel can keep abreast of the rapid increase in scientific knowledge and techniques.

The attitude and interest of agency administrators and research supervisors toward training largely determine the quality of training programs and the participation in such programs. For example: Our survey showed in one location training activities were practically nonexistent, although the opportunities were excellent. In another, with fewer opportunities, dynamic programs were under way as a result of enthusiastic leadership and encouragement.

We found that the desire for formal and informal training is closely related to the academic degrees that a scientist holds . . . and to his age. Those scientists most active in formal university course work were those seeking an advanced degree. After a scientist obtains an advanced degree, he becomes interested primarily in informal training -- working in laboratories with other scientists.

As he increases in years of service, his interest in formal training also shifts. For the most part he becomes satisfied with technical work conferences, short courses in special techniques, and other related types of training. In general, however, the higher the level of training a scientist has, the stronger is his realization of the need and desire for additional training.

In general, our scientists are not well informed about the Department's policies related to training . . . or about the use of various training authorities and mechanisms. Some had no knowledge of the existence of the Government Employees Training Act of 1958, which provides the authority to send our personnel to universities for a year's advanced study. Through this legislation we are permitted to pay their travel and expenses, tuition, and salary, provided the course work taken will eventually benefit the government.

The legislation itself is broad, but there are some practical limitations. For example, all the expenses must come out of the operating budget of the organization, which means that all aspects of the research must be carefully balanced against the merits of advanced study. Moreover, the number of employees who can receive full-time schooling under this Act is limited to 1 percent of the total number of employees in the Department.

During 1963, 40 percent of all employees in the Agricultural Research Service took some kind of service training, financed under the Government Employees Training Act, at a cost of $1 million. Under the Hatch Act funds, administered by the Cooperative State Research Service, we are supporting graduate study for about 2,000 scientists.

And so, the lack of information about such opportunities reflects lack of communciation more than anything else. Scientists themselves were almost unanimous in their belief that a study and retraining program would provide many benefits. It would (1) raise their level of competence, (2) improve opportunities to recruit outstanding personnel, and (3) enhance the Department's leadership in research and education.

In order to strengthen the opportunities for these benefits, we plan to develop a new policy statement on education and training for scientists. Through this statement we hope to reaffirm the interest and concern of the Department in the continued training of scientists in research and education. We want to emphasize as strongly as possible the responsibility of the supervisor to each scientist working with him for the direction and encouragement essential for an understanding of the agency's program. We will emphasize the responsibility of supervisors to make sure each scientist understands the objectives of the research to which he is assigned and the contribution he is expected to make. We will encourage allocation of funds from regular agency appropriations to meet essential training needs.

We will emphasize that the selection of scientists for special training should reflect recognition of professional accomplishment and potential for future growth. We plan to encourage each research and education unit to develop specific training and retraining programs for scientists with goals for each branch, division, and agency.

The Department plans to encourage and assist all research and education agencies to develop a specific procedure for informing all scientific workers of the training opportunities available to them. Each of these agencies should develop a program in which the research leader would determine -- after talking it over with the scientist concerned -- individual training needs. Technical support personnel, particularly those with several years of training, should also be given training opportunities to increase their capabilities and develop their full potential.

We also plan to make more opportunities for scientists to take formal academic courses related to their field of work without reference to fulfilling the requirements for an advanced degree.

In order to increase our support for graduate and other training, the Department will suggest that we be given the legislative authority to sponsor undergraduate, graduate, and postdoctoral scholarships, fellowships, and assistantships. We would like to use every means possible to increase our participation in the training of agricultural scientists through cooperation with universities.

For example, I believe there would be considerable merit in moving more of our scientists into university centers of research and education for brief periods of time. In addition to formal training, the scientists would bring their experience and background to bear on work at the schools. Moving a man from one State to another, with varying agricultural problems, would be certain to bring fresh ideas and concepts into any mutually-conducted work.

The scientists would be expected to take academic courses to bring themselves up-to-date on the latest developments in their fields. From work such as this and from the association with other scientists, the individual would return to his own organization with a broader background to do a better job.

We want to make better use of our own facilities through more intensive intramural programs of training. With our excellent research programs and research facilities at some locations -- and with our outstanding scientific personnel -- the Department has a great potential in training capabilities, such as technical seminars and working conferences. Furthermore, the rapidly increasing demand and competition for qualified scientific personnel make it imperative that these training potentials be used for the development of an interest in science among our youth. These potentials can be used in training of candidates for academic degrees, and for the continued education and training of Department personnel.

Now . . . what about the question of providing adequate support per scientist in the Department? In addition to salary, support includes the subprofessional workers who can relieve the scientist from routine duties that are not essentially research; the necessary laboratory equipment and supplies; and the land, livestock, crops, and produce required in his research projects.

Just two years ago, in 1962, the support for each scientist in the Department averaged $23,000 a year. The current support is about $27,000. A major share of this increase can be traced to Pay Act increases.

We feel that during the next five years we should be able to raise this average to about $35,000 a year. However, a flat average does not give a very clear picture of the situation. For some types of work, the level of support is well above the Departmental average. For example, in research on large animals, the current support is about $44,000 a year . . . and by 1970 we feel this should average about $60,000 a year. In contrast, the support level in economics research is now about $22,000 and should be increased to $27,000.

We have set these modest goals for 1970 for agencies and for divisions within agencies. After a more thorough study, we will establish these goals year by year. We hope to meet them in filling and refilling positions and increasing support per man.

So far, I have been talking about research in our own laboratories. The extramural research program of the Department also has a bearing on our research quality. In the first place, it gives us access to the best research talent and facilities at universities and other institutions. We can use these talents and facilities for exploratory projects to which we are not yet ready to commit Department personnel and resources. Also, extramural grants and contracts with universities support the training of graduate students who are the future scientists for the Department.

During the past 10 years the Department's allocation for research under grants and contracts has been increased from a little over $21 million in 1955 to more than $51 million in fiscal year 1964. This increase has maintained our extramural program at a level above 25 percent of the total Departmental research appropriations, including the funds of the Cooperative State Research Service.

We are already broadening our horizons still further through a new competitive grant program in support of basic research. Under this program, funds were made available for the fiscal year 1964 for grants to the State agricultural experiment stations for fundamental studies on certain commodities.

We are especially pleased with this opportunity as it opens up a new challenge in the conduct of research. It will give the States increased responsibility for doing basic research in areas where they have highly qualified scientists. Furthermore, the competitive aspects of the program will encourage experiment stations to have their best scientists apply for these grants. There has been an increasing tendency for the most competent and creative agricultural scientists to be drawn away from agriculture to more glamorous and better supported research fields. Likewise, these fields have attracted the best graduate students. We <u>must</u> reverse this trend if the quality of agricultural research at universities and in the Department is to remain high.

Another important aspect of research quality is the degree of coordination within a total program.

On the surface, the extremely wide and varied nature of our research program might appear less organized than it actually is. As a matter of fact, very successful coordination has been maintained through the Agricultural Research Service, through regional programs with the various State experiment stations, and by cooperative agreements. Most important of all have been the close relationships maintained among the working scientists themselves.

Additional steps have been taken recently to improve even more on research coordination. One of these is the establishment of the new Research Program Development and Evaluation Staff under my direction.

In addition to personnel who are now concerned with research coordination, this staff will include a new team of 5 of our best scientists who will devote full time to the improvement of administration and program quality. They will provide an organized and continuing arrangement for Department-level research planning, including goals, policies, and programs for long-range and emergency needs. They will also evaluate the Department's research achievements in relation to planned objectives, and the effectiveness of working relationships with other public and private research agencies.

This new office will provide the means of giving more attention to interagency programs . . . and a better organized approach to the Bureau of the Budget, the Congress, and other Federal agencies with which we must work.

The functions of the staff will be carried out in cooperation with research agency leaders.

Another recent step is the establishment of the Agricultural Research Planning Committee, of which I am chairman.

This committee is to be made up of six representatives of State Universities and Land-Grant Colleges; six representatives from research agencies of the Department, nominated by the Director of Science and Education; one member nominated by the National Academy of Sciences; and one member nominated by the Office of Science and Technology. The Vice-Chairman will be a USDA official, designated by the Chairman.

There are six specific objectives of this committee:

(1) To assist in planning, evaluating, and coordinating unified long-range National agricultural research programs and in delineating the appropriate areas of responsibility of Federal and State agencies in carrying out these programs.

(2) To develop further the bases for State and Federal cooperation in planning and implementing regional and interstate research programs.

(3) To facilitate the coordination of plans for additional State and Federal agricultural research facilities to carry out the total effort of publicly-supported agricultural research.

(4) To stimulate selective interchanges of Federal and State scientists to improve liaison and coordination between Federal and State research programs.

(5) To improve communications among Federal agricultural research agencies, the State stations, libraries, and information centers.

(6) To stimulate and foster training programs for promising young scientists so as to insure a continuing supply of well-trained manpower.

We will make the best possible use of these two new groups, but not at the expense of the freedom and responsibility of the various research agencies. The Committee and the staff have been established to facilitate and improve research progress . . . not hamper it. We expect to continue giving scientists themselves the major responsibility for research planning.

I have discussed briefly some of the methods we in the Department and our counterparts in the State experiment stations are using to maintain and improve research quality. Perhaps I have given the impression that I think this quality can be "legislated" or "administered" into a program by setting up procedures, rules, guidelines, committees, and directives for the scientist. If I have done so, let me take this opportunity to dispel any such impression.

Research quality comes from the minds and the activities of the scientists. All that administrators and managers of research can do is to provide a climate for the scientists in which their creativity is most apt to be exercised. Every new committee, task force, training program, and coordinating mechanism must contribute to the objective of providing this kind of climate.

So . . . in short . . . the opportunity for improving the quality of research in the U. S. Department of Agriculture is as great if not greater than it has ever been. But it will take work to achieve these improvements . . . work on the part of the scientists themselves . . . supervisors . . . and Department and experiment station administrators.

There is no more important link in this chain than the supervisor of working scientists. He has much to do with creating the proper climate I mentioned . . . stimulating interest . . . offering the opportunities for growth and development of the individual scientist.

We must do a better job of presenting the facts about agricultural research to those who have the responsibility for providing supporting funds . . . the Office of the Secretary of Agriculture, the Bureau of the Budget, and the U. S. Congress.

We must present the facts to groups outside of government so that they can have a full knowledge and understanding of the high quality of our research . . . and can support and emphasize that quality.

In presenting these facts . . . in obtaining this support . . . we must have the help of those outside the State and Federal agricultural research family whom the research will benefit. This means the general public . . . but more especially it means those in agriculture and related fields. Their support must be active and it must be directed to those in a position to provide the funds on which research quality is so dependent.

Even though we are proud of the quality of agricultural research today, we cannot be satisfied with it. We must take these steps to improve it and protect our potential to meet the challenge of the future.

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PRINCIPLES OF AGRICULTURAL RESEARCH MANAGEMENT IN THE UNITED STATES

By DR. NYLE C. BRADY,
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Talk by Dr. Nyle C. Brady
Director of Science and Education
U. S. Department of Agriculture
before OECD Committee for Agriculture
Paris, France
October 19, 1964

PRINCIPLES OF AGRICULTURAL RESEARCH MANAGEMENT IN THE UNITED STATES

The rate of accumulation of knowledge through scientific activity this century has been without parallel in human history.

This restless urge to discover the ". . . deeply hidden something that has to be behind all things," as Einstein has said, is generally recognized as the force underlying all progress.

In my own country, we have rapidly developed and implemented scientific knowledge and technology as a matter of national policy. Agriculture in particular has been uniquely successful in utilizing science to attack and solve many of the age-old basic problems of life, and help our people to achieve a more meaningful, more hopeful existence.

Although research has always been important in developing our agricultural technology, since early this century it has been assuming an increasingly critical role. There is no question that it will be the key factor in any future progress.

Publicly supported agricultural research in the United States had its major beginnings in 1862, following enactment of two Federal laws creating the Department of Agriculture and the land-grant colleges. Legislation in 1887 made Federal funds available to the States on a continuing basis, to establish and operate agricultural experiment stations as part of the land-grant colleges. In 1914, legislation was enacted by the Congress to set up a cooperative Federal-State agricultural extension service to bring new research ideas and techniques to people on the farms, where they could be put to practical use.

Thus was established the legislative framework for our Federal-State system of agricultural research.

Through the years, it has developed to meet both local and national needs, due largely to the great variations in the climate and physical conditions of our Nation . . . and our long-standing belief in the rights of the individual States.

In the broad sense, agricultural research in the United States includes more than the research of publicly-supported agencies -- that is, the State experiment stations and the U. S. Department of Agriculture. It also includes the increasing amount of research that is being conducted by farmer organizations, by private foundations, and by many food and farm-related industries. These groups have made and are continuing to make important contributions to the richness and diversity of our agricultural enterprises.

I would like now to show you some slides that illustrate this nationwide structure for agricultural research and how it functions . . . and the techniques developed to administer research to make it responsive to the needs of over 190 million American people.

In order to understand the overall structure, we will begin with the Federal organization for science in the United States.

CHART 1

The organizations you see here have been created only recently in the Executive Branch of our Government, to cope with the numerous and increasingly sophisticated problems in science communication, management, long-range planning, policy making, and allocation of resources and personnel. Each has well-defined responsibilities in advancing the Nation's extremely diverse scientific activities.

The Office of Science and Technology is a permanent staff unit which assists the President in developing policies and evaluating programs to make sure that science and technology are being used most effectively to promote the Nation's welfare and security.

The President's Science Advisory Committee is composed of outstanding scientists from universities, industry, and private organizations to advise him on the role of the Federal Government in furthering science. It undertakes special studies designated by the President and initiates many of its own, some in the field of agriculture.

The Federal Council of Science and Technology, composed of representatives of the eight Government agencies conducting research, is concerned with more effective planning and administration of Federal scientific and technological programs. The Council's membership includes the Departments of Defense; Health, Education, and Welfare; Interior; Commerce; and Agriculture; and the National Science Foundation, Atomic Energy Commission, and the National Aeronautics and Space Administration.

The United States Government is spending about $15 billion this year to support the research activities of these agencies.

CHART 2

Less than 1½ percent of the $15 billion Federal research budget is expended for agricultural research. This is a substantial drop in percentage from 1940, when agriculture received some 40 percent of the $74.1 million the Federal Government was spending for research.

Let us consider agricultural research in terms of budgets.

CHART 1

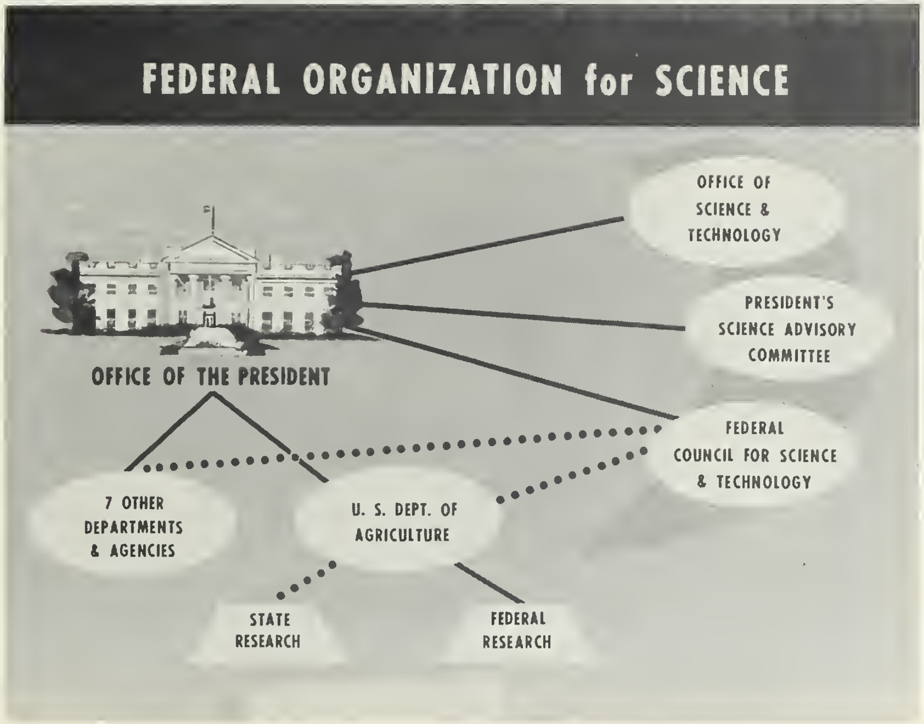
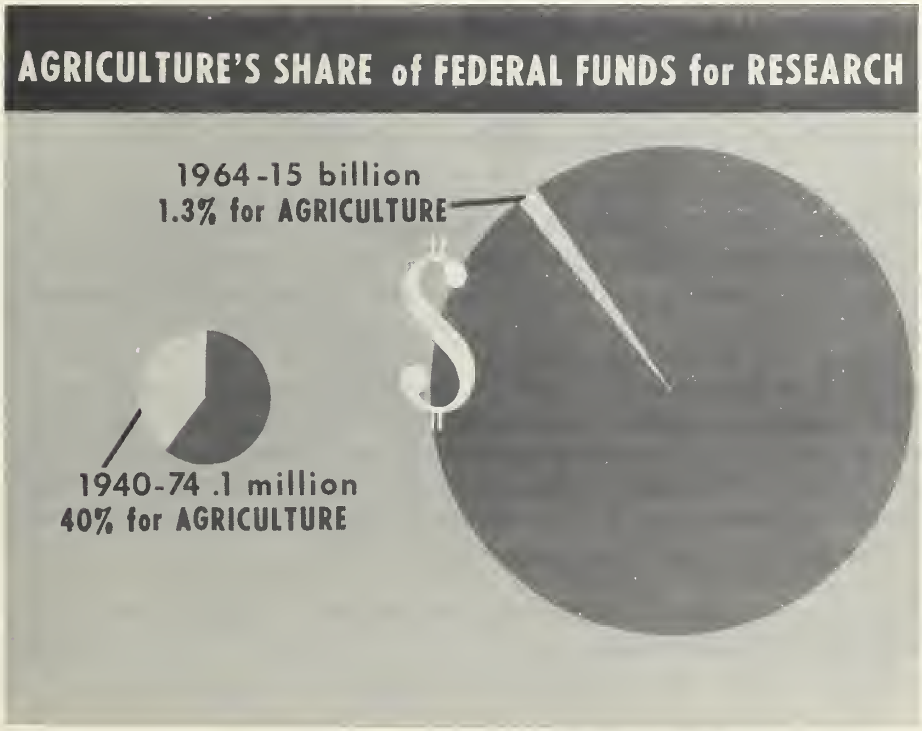


CHART 2



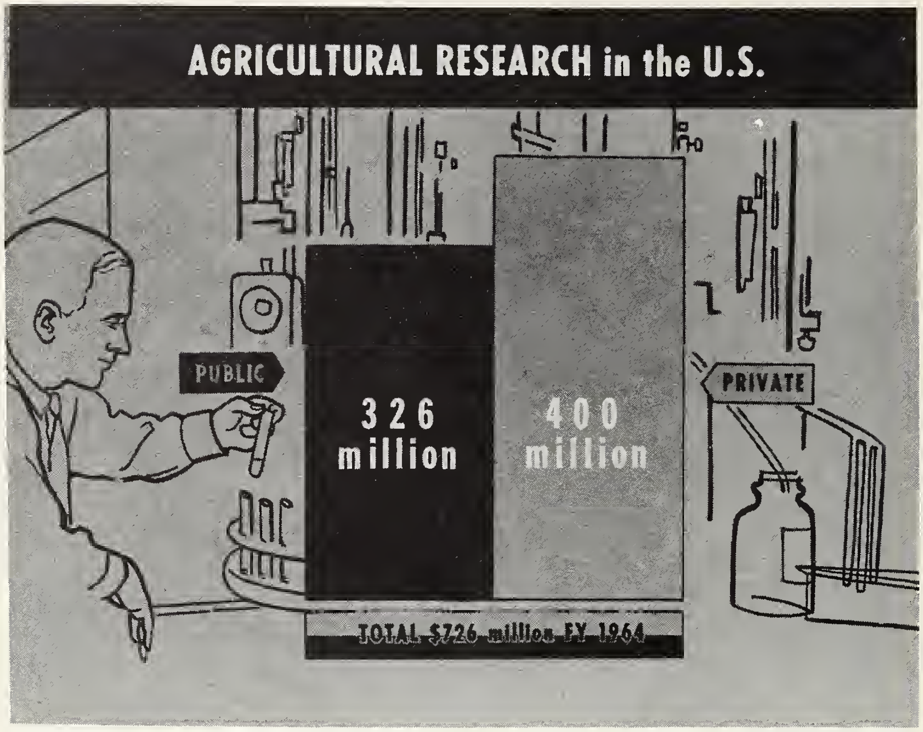


CHART 3

As I have indicated, agricultural research in the United States is a joint effort of public and private agencies.

The public partners -- that is, the Department of Agriculture and the State agricultural experiment stations -- are spending approximately $326 million. This includes $10 million transferred to the Department this year from other Department agencies for specific work.

Our best estimate of what private industry spends for agricultural research is approximately $400 million. Industry has become a major force in agricultural research in the last few decades -- because of the machinery, chemicals, and biologicals that industry supplies to agriculture, and because of the raw materials that agriculture provides to industry.

Total funds for agricultural research in our country amount to approximately $726 million.

#31.3

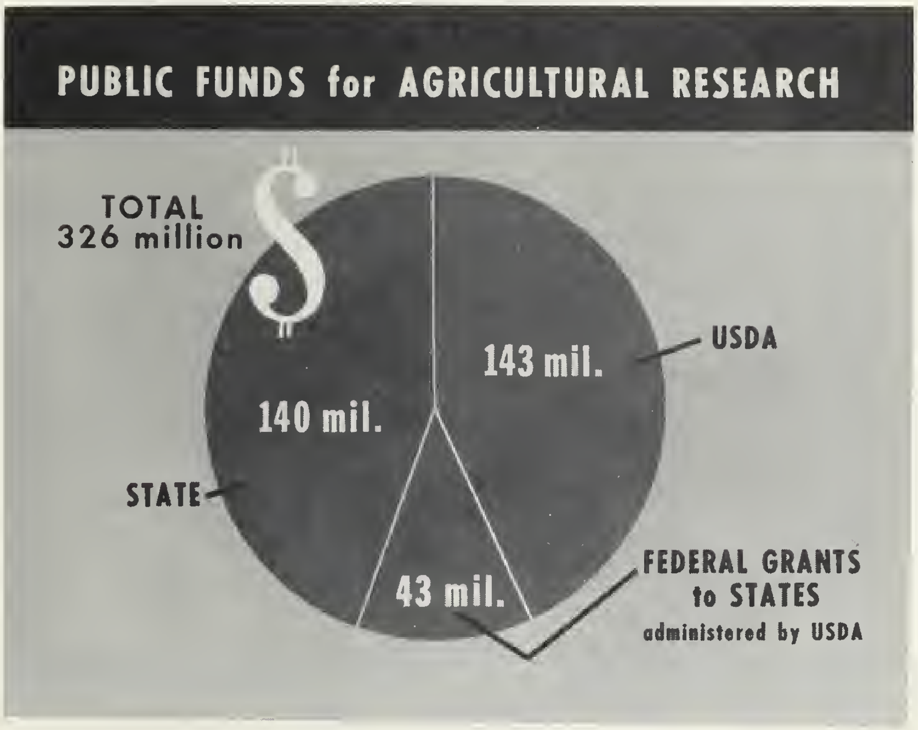


CHART 4

Now, let's examine the <u>public</u> funds for agricultural research a little more closely.

The $140 million that the States provide includes $7 million that is made available to them by industry for agricultural research.

The Federal Government provides $143 million for the Department of Agriculture and $43 million for Federal grants to the States. Part of these Federal-grant funds, by the way, are distributed equally to each State, and the rest in accordance with a formula based on the State's rural and farm population. Incidentally, these figures represent the operating budget and do not include funds for facilities.

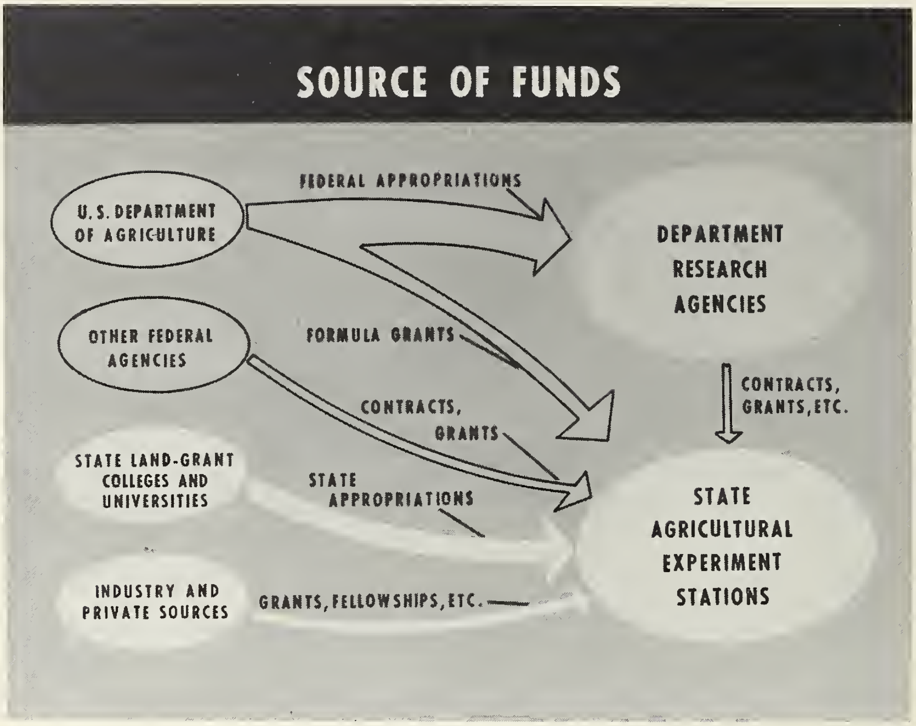


CHART 5

Here you see the source of all of the funds that are spent for agricultural research by the State experiment stations and research agencies in the Department. The width of the arrows indicates the amount of funds distributed; the color, where the money comes from.

You will note that the Federal appropriations allocated to the Department of Agriculture comprise the major source of money for agricultural research, with Federal grants to the States an important part of these appropriations. As you can see, State appropriations going to the State experiment stations at the land-grant colleges are the second largest source of funds for agricultural research.

Money also comes from Federal agencies other than the Department of Agriculture through contracts and grants; from industry and private sources through grants and fellowships; and from various research agencies of the Department of Agriculture through contracts, cooperative agreements, and grants.

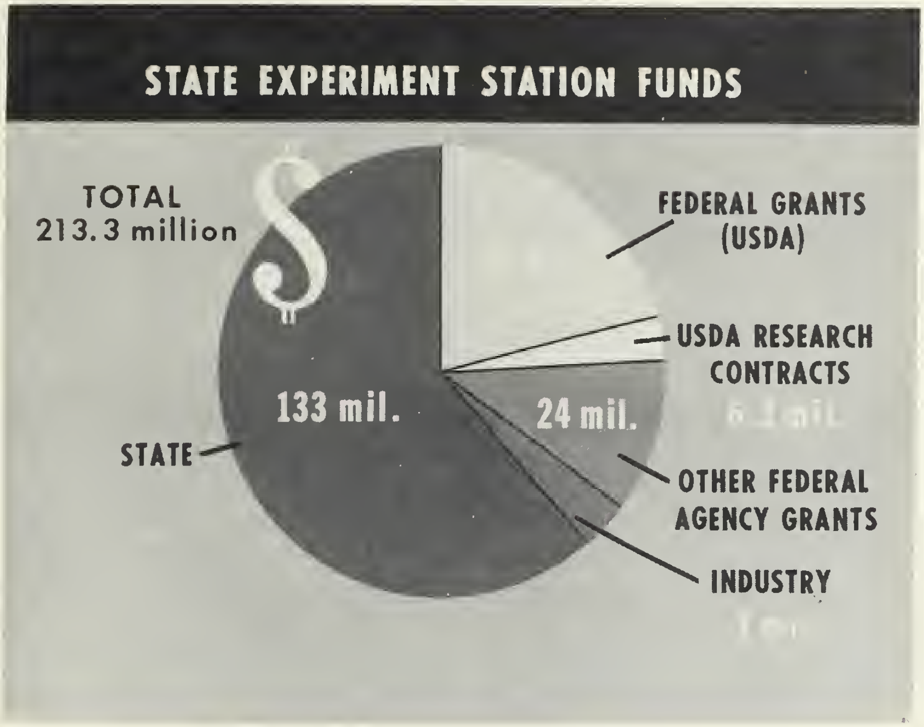


CHART 6

Here you see what these sources actually contribute to the research budget of the State experiment stations, which this year totals $213.3 million.

Approximately $133 million of this amount is actually provided by the States, although the $7 million from industry, as I have indicated, is generally considered as part of State funds. The Federal grants that the Department administers, along with the Department research contracts, amount to approximately one-fourth of the funds available to the States.

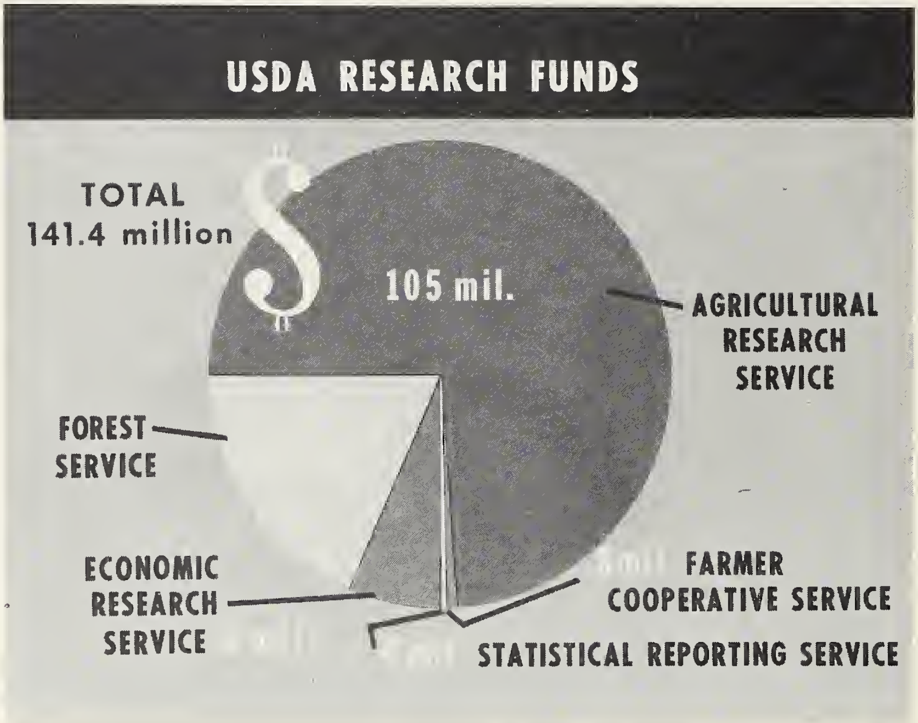


CHART 7

Here you see the same breakdown of funds for the five agencies in the Department of Agriculture that conduct research. These include the Agricultural Research Service, Forest Service, Economic Research Service, Farmer Cooperative Service, and the Statistical Reporting Service.

You will note that the Agricultural Research Service accounts for approximately three-quarters of the Department's total research effort.

When the total of $141.4 million is added to the $1.6 million allocated to the National Agricultural Library and listed as research, we come up with the figure of $143 million, the current operating budget for agricultural research in the Department of Agriculture.

So far, I have talked mainly about agricultural research in terms of budgets. Now, I want to take some time to talk about how we plan, manage, and coordinate research . . . and the organization through which research operates.

#31.3

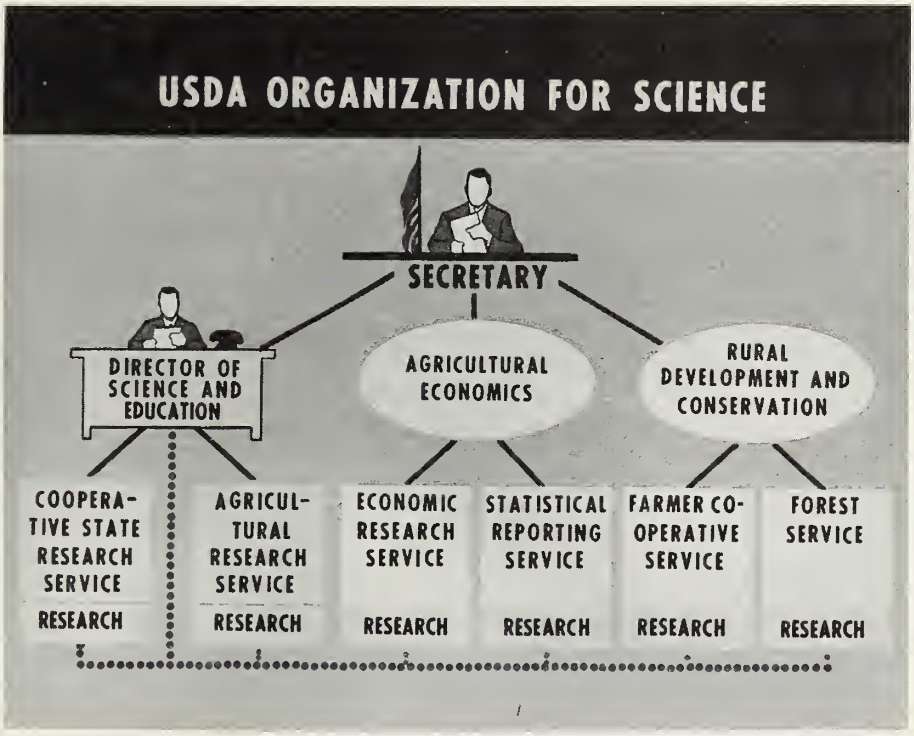


CHART 8

Here is the Department's basic organization for science.

In addition to the five agencies I have already listed, there is also the Cooperative State Research Service. This is the agency within the Department that administers the Federal-grant funds to the State experiment stations. The Federal-grant funds support about a fourth of the research of the State experiment stations, with the States, industry, and foundations providing the rest.

You will notice that the Director of Science and Education is directly responsible for only the Agricultural Research Service and the Cooperative State Research Service. Research in the other four agencies supports the highly specific objectives of those agencies. It is, however, fully coordinated through the Director's office.

It is because of these extensive relationships among Department research agencies that major problems in coordination arise.

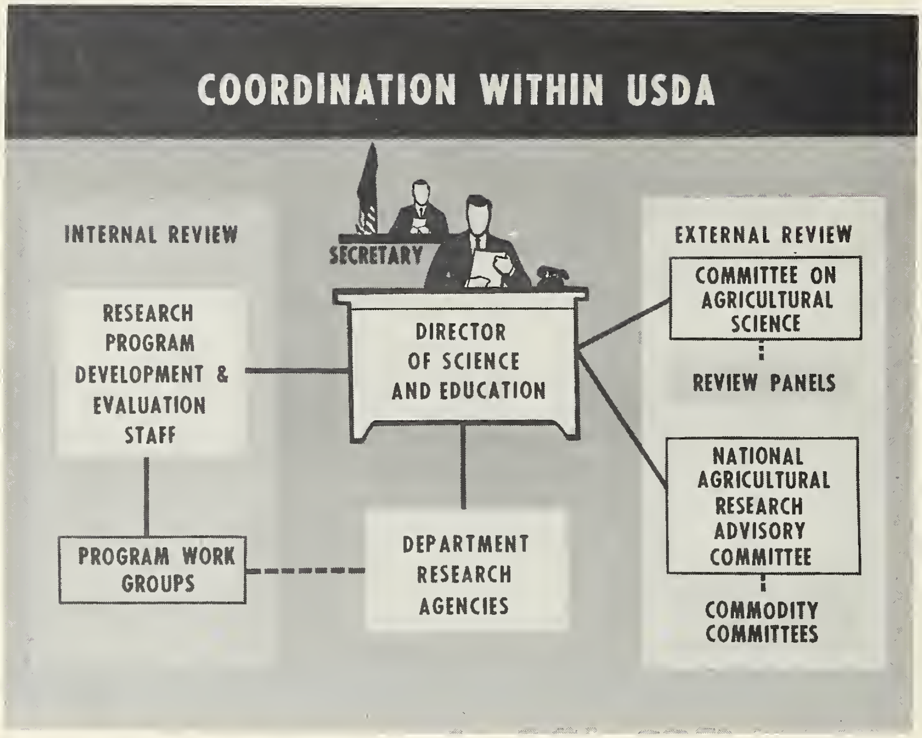


CHART 9

In coordinating research in the Department of Agriculture, we have the help of the administrators of the various research agencies and the assistance of various committees and groups, both in and outside the Government. Each of these committees and groups has responsibilities for bringing order and direction into a large and complex research establishment. They help us to determine if we are doing a good job . . . and if we are making adequate plans for the future.

To begin with, internal review is carried out through the newly formed Research Program Development and Evaluation Staff. This organization has major responsibilities for assisting in the overall development of the Department's research programs. It will be coordinating research activities among Department agencies and with State, private, and other research organizations . . . and it will be carrying on a continuing evaluation of research to determine if goals and needs are being met.

The new staff will have the assistance of various program work groups to conduct whatever detailed, specialized studies are necessary to carry out its responsibilities.

External review and advice for carrying out the Department research programs come from several sources. One is the Committee on Agricultural Science, composed of 15 of the Nation's outstanding scientists. This Committee conducts a continuing evaluation of the research supported by Federal funds, particularly work of a basic nature, with a view to appraising our capacity for significant research. Review panels assist in planning and maintaining cooperation between agencies of the Department and research in closely related fields.

Next, we have the legally required National Agricultural Research Advisory Committee, whose members are concerned with various aspects of agriculture. This committee makes recommendations to insure broad coverage of all important areas in agriculture in the interest of maintaining a comprehensive, dynamic, and flexible research program.

This committee maintains contact with 12 advisory or commodity committees, which review various segments of our current research and recommend adjustments. These unique committees, representing all aspects of agricultural problems, offer an ideal system of communication between the Department and consumers and farmers.

Coordination of research with other Department and Federal agencies is accomplished through Department membership in the Federal Council of Science and Technology . . . and representation on all interdepartmental committees dealing with problems of interest to the Department of Agriculture.

In addition, the Department participates in the Science Information Exchange, which provides first-hand knowledge of all Federal research projects in each field.

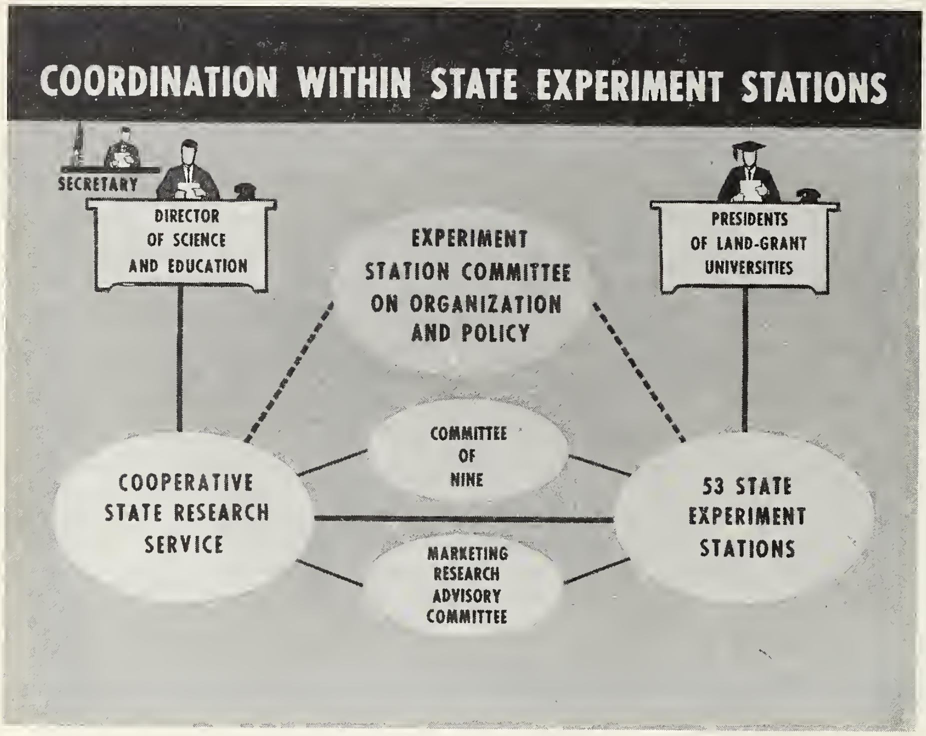


CHART 10

In coordinating research within the State experiment stations, the directors have the assistance of an old and well-established group -- the Experiment Station Committee on Organization and Policy. This Committee of elected Experiment Station Directors participates with the Cooperative State Research Service and the Department of Agriculture in formulating policies on the cooperative research programs of the States and the Department.

The Committee of Nine, which you see here, is chosen by the Directors of the State experiment stations to recommend the regional studies that are supported by funds under the Hatch Act.

The Cooperative State Research Service, which administers the work supported by Federal-grant funds, makes sure that the money is spent as Congress intended. It also gives the State experiment stations technical assistance in the planning and conduct of research.

The Marketing Research Advisory Committee reviews Federal-grant research and recommends any changes that may be needed.

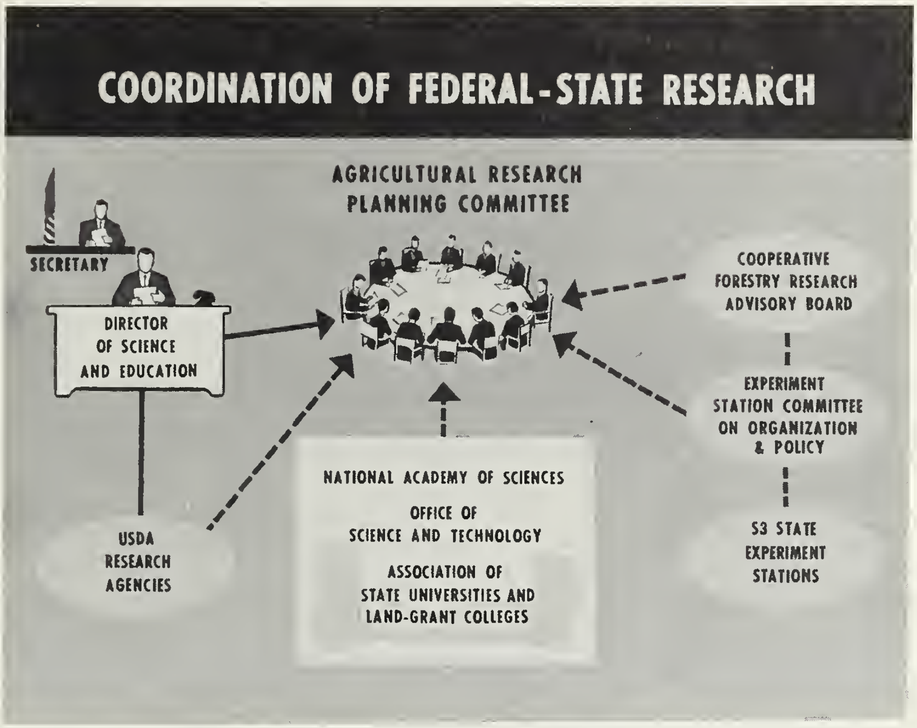


CHART 11

Coordinating Federal-State research is a major task when you consider the parts of the structure -- the land-grant colleges and universities, the State agricultural experiment stations, the several agencies of the U. S. Department of Agriculture, and the several hundred State and Federal stations at different locations throughout the Nation.

The recently established Agricultural Research Planning Committee will provide a strong base for coordinating the research programs of all these agencies. This group will assist in working out long-range national agricultural research plans and goals and in determining the areas of Federal and State responsibility in carrying them out. Other responsibilities include improving Federal and State cooperation in broad regional research, helping coordinate plans for Federal and State research facilities, and stimulating interchange of scientists at all levels.

Membership in this group includes representatives of Department research agencies; Station directors selected by the Experiment Station Committee on Organization and Policy; a president of a land-grant university, selected by the Association of State

Universities and Land-Grant Colleges; and representatives from the National Academy of Sciences, and the Office of Science and Technology.

The Cooperative Forestry Research Advisory Board, made up of representatives of State, Federal, and private agencies, gives advice in carrying out a nationwide program of cooperative forestry research, which was recently authorized under the McIntire-Stennis Act.

These broad review and coordinating services help the experiment stations and the Department to avoid research duplication, to recognize where work needs to be done, and to plan and carry out a more effective Federal-State program of agricultural research.

CHART 12

Research is coordinated in other ways as well. For one thing, the States and the Department each have definite research responsibilities. Each State is responsible for work of interest to its people. The Department is responsible for work of national or regional significance, generally in cooperation with one or more States. In cooperative work of mutual interest, State and Federal people decide jointly what portion each will undertake. To help us make these decisions, we utilize committees of State and Federal specialists in the major areas of research.

There is continuous close association between the 2,300 Department people working in the land-grant colleges and experiment stations, and the State people who work in these places. Frequently, Department scientists teach courses on a part-time basis in their fields of study. Faculty members of the land-grant colleges may undertake special research projects for the State experiment station or the Department of Agriculture.

CHART 13

Coordination is achieved in still another way -- through maintaining and using up-to-date inventories of all current research projects. This research project system, which we are in the process of modernizing, helps us in examining and analyzing all current and proposed Federal and State research.

Currently, the Department of Agriculture maintains detailed records of some 3,700 Department research projects. The Cooperative State Research Service maintains similar records on approximately 6,700 State-supported projects, and 6,400 projects financed all or in part by Federal funds. Both sets of records provide the background information on current work against which all proposed new projects

CHART 12

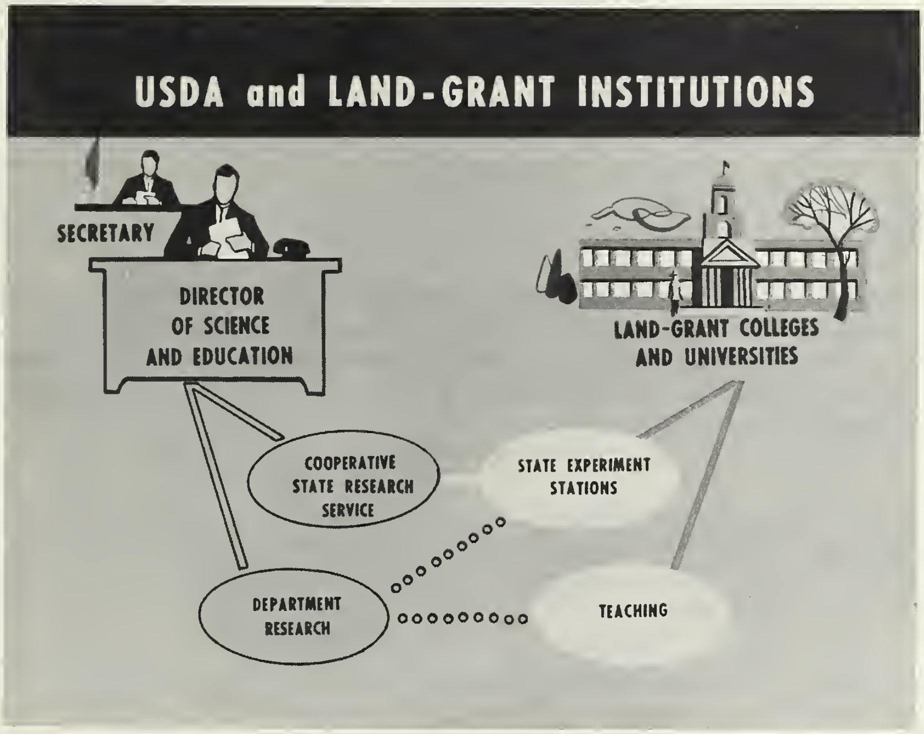
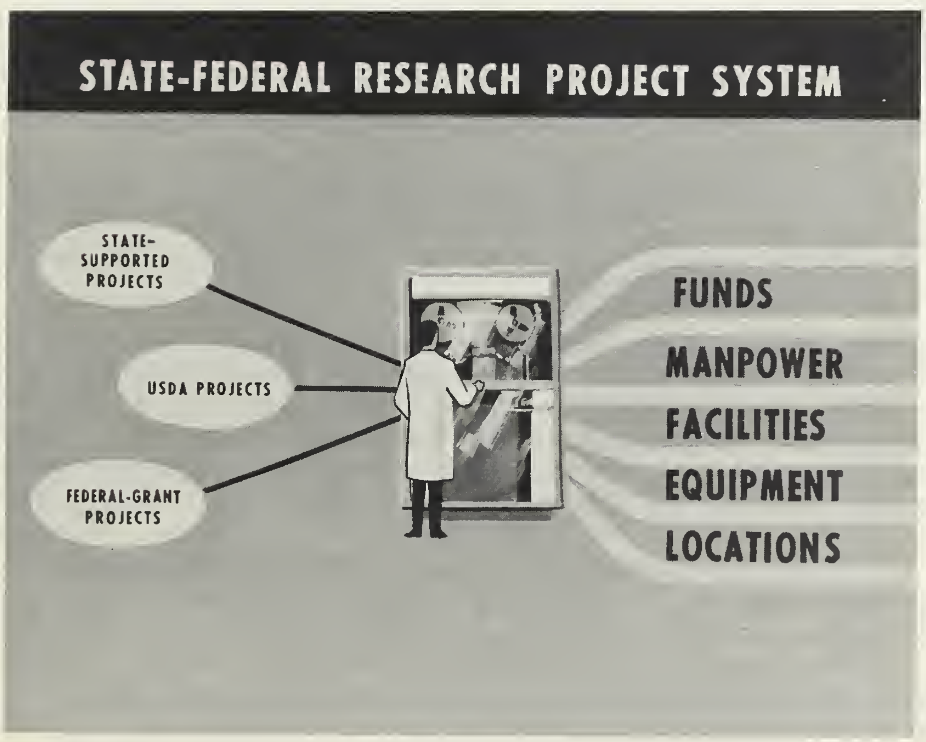


CHART 13



to be supported by Federal funds are examined. This is the key to effective coordination and prevention of unnecessary duplication.

According to current plans, we expect to have the records of the State-supported projects, Department projects, and Federal-grant projects fully automated, and located in one place. This will involve extensive voluntary cooperation on the part of the experiment stations in providing information on State-supported projects, over which the Department exercises no control.

The improved system for maintaining research project records will provide a source of communication between scientists on all aspects of current research programs. And it will provide comprehensive information to permit ready analysis of research for more effective management.

From what I have said and the slides I have shown, I hope that you understand the scope of our nationwide organization for agricultural research . . . and the procedures through which research is planned and resources are committed.

To summarize -- before I move on to my next point -- publicly supported agricultural research in the United States is carried on jointly by the Department of Agriculture and the autonomous State land-grant universities, each with its college of agriculture and experiment station. Farm and industry organizations and other groups assist in planning the research, and cooperate and coordinate in carrying it out.

The methods for planning and managing agricultural research involve a high degree of voluntary cooperation between the States and various agencies of the Department of Agriculture. The management procedures include continuous review from many different points of view to insure that research is meeting all the important problems of the time.

Although our public agricultural research involves Federal and State action and wide dispersal of activities, the important thing to remember is that it is essentially a cooperative program directed to a single national purpose -- the most efficient production, processing, marketing, and distribution of our farm products. And it takes into account the varying conditions and needs of the individual States.

These, then, are some of the principles of research management. But what about the day-to-day operation -- the working organization through which authority is delegated and control is achieved?

Federal and State agricultural research is broken down into approximately 16,800 projects in a dozen or so subject-matter fields. The problems, objectives, and plan of work are clearly defined for each project. Projects are assigned to scientists located in the first main organizational structure, which, in the Department of Agriculture, is the branch. This, in turn, is part of a larger organizational structure, the division, which may include as many as ten branches. The division chief is responsible to the administrator of his research service. And the research administrators answer to the Director of Science and Education, who is answerable to the Secretary of Agriculture.

Similarly, in a State experiment station, the project leader is a staff member in a subject-matter department. The department head is responsible to the director of the experiment station. He, in turn, is responsible to the president of the institution, either directly or through a dean of agriculture. Funds, personnel, and all other research resources are managed and controlled through these organizations.

So far, I have talked mainly about financing and coordinating research. Now, I want to take a moment to talk about the techniques for keeping up with the new problems created by changing conditions. Where do the ideas and the proposals for research come from?

CHART 14

In most cases, scientists in the Department of Agriculture or the State experiment stations recognize and define problem areas and develop research approaches to solve them. Scientists outside the Department and the Federal Government also contribute to the flow of research ideas.

In some cases, farmers themselves recognize a new disease or a problem that needs research attention. Farm organizations and publications, and local civic groups, may point the need for new work. Frequently, Extension Service agents, through their day-to-day contact with farmers, recognize special problems.

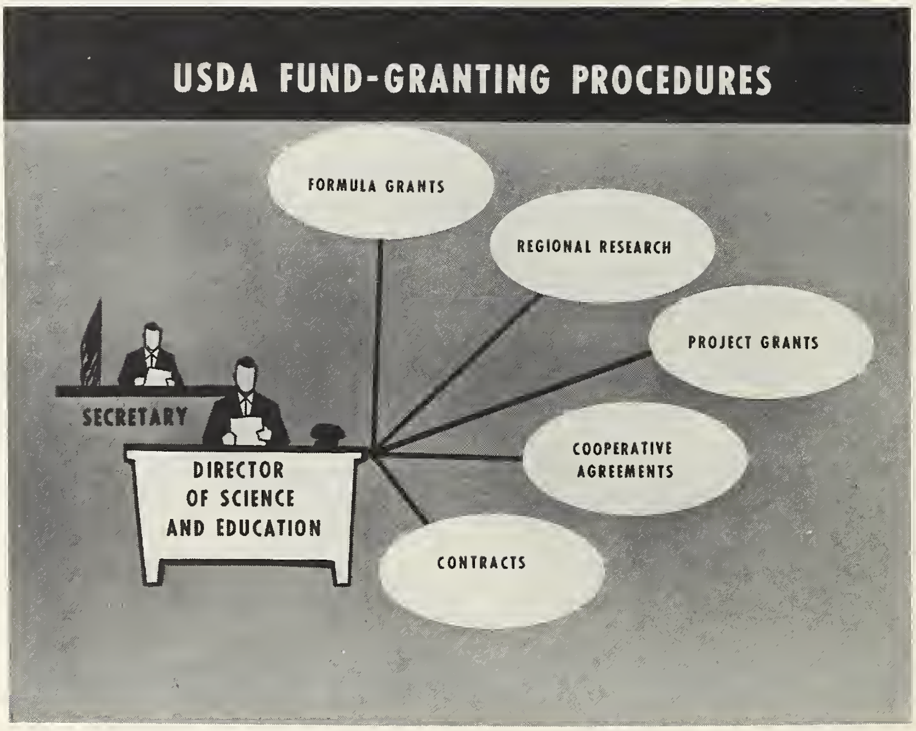
There is a constant screening and sifting of ideas and proposals, and many more are suggested than we can possibly handle.

There are the inevitable pressures to perform work of special interest to a particular group. Sometimes, when it is to our advantage also to do the work, we will go along. But, if it is a matter of science versus political consideration, science is given our support, as it must be in order to survive.

It is no easy matter to decide where to put the research money among different fields, and more difficult still to balance our total resources in general areas of research. Ultimately, we are

CHART 14

CHART 15



guided by public need and public opinion in recommending the overall balance of our research effort.

Now, knowing where research proposals come from, let's look at the channels through which research funds are allocated.

CHART 15

As you can see, there are several ways to get work done.

The so-called formula or institutional grant -- which is the most widely used -- assures a broad geographic distribution of research support, and the continuity of funds permits long-range planning. The institution receiving the money largely determines the nature and extent of the work to be done.

The highly competitive project grants are awarded primarily to individual scientists on the basis of their competence, rather than the institutions they represent. Research under this method is largely basic and controlled by the scientists themselves.

Regional research is a cooperative Federal-State venture involving investigations on problems of mutual interest to several States, as provided for in the law authorizing Federal-grant funds. Several State experiment stations and one or more Federal agencies may be involved in the joint planning and conduct of regional research. About 25 percent of the Federal research funds available to the States is devoted to work of this kind.

Contracts are given for specific research, for a stated period of time. The research is usually done to meet a particular need.

Cooperative agreements are arrangements made between the Department research divisions with public or private research agencies to conduct research of mutual benefit to both.

The Department's Agricultural Research Service maintains a contingency fund which is used for research when a serious and unexpected agricultural problem arises.

If this brief description of our fund-granting procedures gives the impression that our research is largely applied and oriented to specific problems, I wish to emphasize that we are very conscious of the importance of basic research. Fully a third to a half of our total research effort can be characterized as basic, and the figure has been increasing for some time.

Regardless of what work we choose to do, however, or how we choose to do it, research will proceed only as there are competent scientists to do the work.

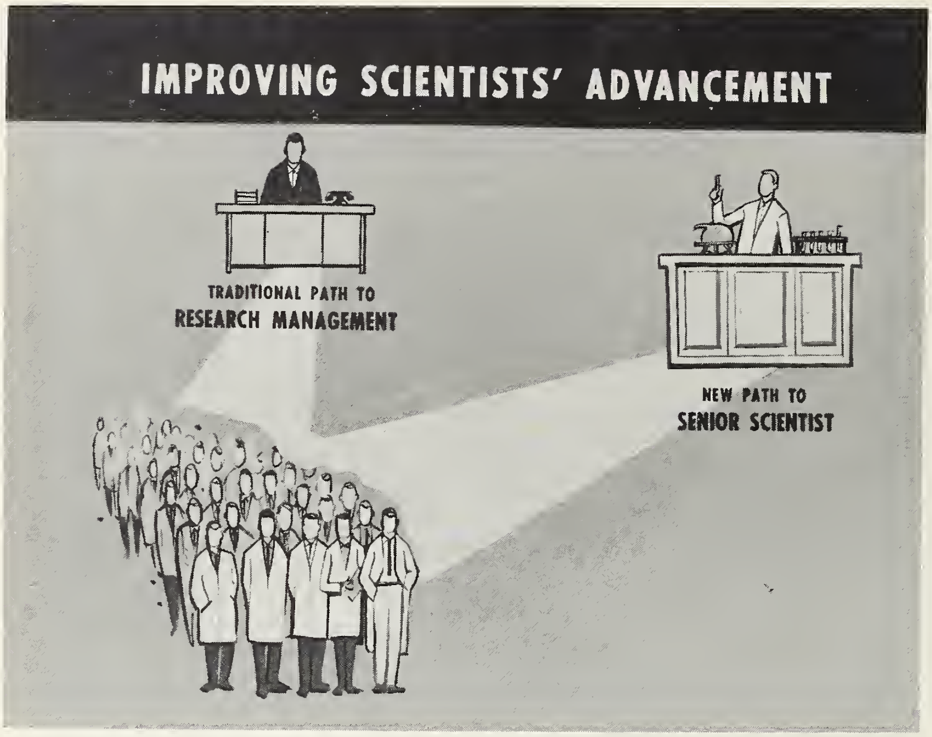


CHART 16

In a recent move to increase the effectiveness of our staff, the Department of Agriculture instituted a policy of advancing able young scientists on the basis of their growth as scientists, instead of making them go through the traditional path of research management. Thus, those scientists who wish to stay in research have the opportunity to progress just as rapidly as those who choose to go into research management.

On the whole, we have encouraged our people to take every available opportunity for additional training and coursework and to study for advanced degrees. We have used our limited legislative authority to pay the necessary expenses for much of this schooling.

Just recently, however, we completed a comprehensive study which pointed up how much more could be done to make sure that scientists keep current with changes in their disciplines . . . and to give them the necessary environment to permit individual and scientific growth.

The study recommended that we intensify our efforts to give scientists the training and retraining they need to increase their effectiveness . . . and that we establish a comprehensive leave program for this purpose. Technical support personnel also must be given training opportunities to develop their full potential.

The study stressed the importance of an intellectual and scientific environment. It suggested closer cooperative relations with colleges and universities, and recommended that all new research facilities be located on or near a university campus.

Members of the study group also recommended that the Department obtain legislative authority to sponsor undergraduate, graduate, and postdoctoral scholarships, as well as fellowships and assistantships. And it recommended that we work with colleges and universities in developing courses of study to meet future needs for scientists. Particular emphasis is placed on additional study for scientists who have been out of classrooms for five or more years. For, as our experts tell us, much of what university graduates learn today is obsolete in as little as ten years' time. And further, much of what they will have to know is not even available today.

We plan to implement as many of these recommendations as we can. We feel a strong obligation to make the fullest use of our trained people . . . and to provide them with the retraining necessary to keep pace with the rapidly advancing scientific frontiers.

In broad outline, then, these are the ways that our nationwide structure for agricultural research operates. It is an extraordinarily effective structure -- one that is uniquely American in its inception and growth, although it certainly was not planned with any grand design for the future in mind.

It is, I suppose, an outgrowth of attitudes more than talent, for bright people are found everywhere. It comes from a national conviction that if a group of people work hard enough and long enough to solve a problem, then it gets solved. And it stems, too, from a basic regard for the values of human life and good standards of living.

If, as someone has said, culture is wine and cheese, and civilization is bathrooms and plumbing, I say it is the task of agriculture to provide the kind of abundant economy that will make both possible.

FEDERAL-STATE RELATIONSHIPS IN RESEARCH AND EDUCATION

Talk by Dr. Nyle C. Brady, Director of Science and Education, U.S. Department of Agriculture, before the Association of Land-Grant Colleges and State Universities, Washington, D. C., November 10, 1964.

This is the first time that the Department of Agriculture has been represented at your meeting by a Director of Science and Education. It is a pleasure for me to meet with you as the first person to occupy that position.

As you know, both the title and the division of responsibility are new. For the first time, a member of the Secretary's staff can concentrate his full attention on the Department's science and education activities without being burdened with the overall supervision of several other agencies. This change is in line with the recommendations of the President's Science Advisory Committee.

Perhaps you may wonder what I can suggest, after a little less than a year on the job, about improving Federal-State relations. I cannot speak from experience or with a knowledge of all the rules. In some cases, this has been a handicap. In others, it has helped get jobs done that I was told could not be done. I am convinced that a certain amount of ignorance can be helpful!

Secretary Freeman recently commented that the working partnership between the Department and the State Experiment Stations has been one of the world's great miracles. Overall success, in terms of research and application of results in agricultural production and agricultural products, is second to none.

But there is no need for me to tell this group about past successes. Instead, I would like to comment on mutual problems and tell you some of the recent actions the Department has taken in attacking those problems.

Mutual Problems in Federal-State Relations

First, there is the matter of communication among Federal and State scientists and administrators. We need to do a better job of informing one another about what we are doing -- and why.

Certainly, all of us are doing our utmost to avoid unnecessary duplication of effort. But, with more than 17,000 research projects being conducted by Federal and State scientists, the task of keeping each other informed is enormous. Similarly, our broadened responsibility for education, often involving cooperation with numerous public agencies and private groups, is accompanied by a complex communication problem.

In addition -- and perhaps even more difficult -- we must let others know about the effective lines of communication between the Department and the 50 States and Puerto Rico. We need to assure the public that we are operating in unison, as an effective team. And particularly, we have to convince members of the executive and legislative branches of Federal and State governments that we have the closest working arrangements.

A second problem lies in the area of mutual planning of programs and facilities. Here again, Federal and State research administrators recognize the desirability of meshing our efforts. We know that a unified effort will make the most effective use of financial, physical, and manpower resources. Having sat on both the Federal and State sides of the table when making planning decisions, I certainly appreciate the difficulties involved. Where I sit now, I am constantly faced with convincing the Secretary, the Bureau of the Budget, and the Congress that we are working together in our planning.

Another mutual problem is in obtaining support for our programs. It is not surprising that we tend as individuals to think first of getting backing for our particular research -- Federal or State. But we sometimes are guilty of competing with each other, when we should be assisting one another to gain the approval and resources required for carrying out work that is mutually beneficial.

We cannot afford the luxury of competition for support within the agricultural research and education community. The necessary large expenditures for such new research efforts as the programs in defense and space travel have forced a relative reduction in national emphasis on agriculture. Even though the Federal research appropriation for agriculture in fiscal 1964 was more than six times the number of dollars provided in 1940, the proportion of the Federal research budget devoted to agriculture declined from 40 percent in 1940 to 1.3 percent in 1964.

A fourth problem is our competitive position for our fair share of the Nation's brains and competence, in relation to those outside agriculture. Defense and space research are attracting many bright young men and women we must have to staff our laboratories. We face the task of convincing undergraduate and graduate students -- as well as young people still in high school -- of the challenges and opportunities open to them in agricultural research and education.

It is to the advantage of the Federal as well as the State components of our team for the prestige of study in agricultural disciplines to be as high as in any other field in our universities. At the present time this is not the case. We must take action through special fellowships and assistantships, through support from agricultural sources for our best scientists, and through any other effective technique to attract people of competence to agriculture.

Having attracted them, we need to keep them. Attention should be given to the support each scientist has to carry out his work. The only limitation on the accomplishment of a scientist or educator should be his own creative ability. We are examining this situation within the Department and hope to increase, by about 30 percent, the average support per scientist by 1970. We would encourage Land-Grant College administrators to do likewise.

Improving Research Administration and Coordination

Faced with these problems of communication, coordination, and competition, we must be aggressive in our search for solutions. Our methods of administrative management must be re-examined and refined where necessary. The Department is engaged in a continuous re-examination.

Analyses of research programs have always been a part of administrative responsibility. This responsibility is constantly met through the use of judgments and decisions. Frequent studies and surveys have been made over the years to check on the possible need for shifts of emphasis to meet changing trends. The responsibility for administrative judgment has been met successfully in agricultural research. The outstanding progress of our agriculture is one proof of that point.

I don't want to give the impression that I think research quality can be "legislated" or "administered" into a program by setting up procedures, rules, guidelines, committees, and directives for the scientist. All that administrators and managers of research can do is provide a climate for the scientists in which their creativity is most apt to be maximized. Each new committee, task force, training program, and coordinating mechanism must contribute to the objective of providing this kind of climate.

With this preface, I would like to tell you of recent actions we have taken.

Last month the new Agricultural Research Planning Committee, of which I am chairman, had its first meeting. The major assignment of this committee is to facilitate the planning and coordination of research in the Department with that in the States and other research agencies.

The State Universities and Land-Grant Colleges have six representatives on the committee -- a university president, four Experiment Station directors, and a member nominated by the Cooperative Forestry Research Board. President J. H. Jensen of Oregon State University was nominated by your Association. The Experiment Station Committee on Policy nominated O. G. Bentley of South Dakota, T. W. Dowe of Vermont, L. E. Hawkins of Oklahoma, and M. L. Peterson of California to represent the four regions of the country. R. J. Preston, Jr., of North Carolina State was nominated by the Forestry Research Advisory Board.

The committee also includes six administrators from research agencies of the Department -- B. T. Shaw, T. C. Byerly, H. A. Rodenhiser, F. R. Senti, C. P. Heisig, and V. L. Harper. One member, M. M. Rhoades, was nominated by the National Academy of Science, and one -- K. A. Folkers -- was nominated by the Office of Science and Technology. E. C. Elting of my staff is its Executive Secretary.

The committee has six specific objectives:

(1) To assist in planning, evaluating, and coordinating unified long-range national agricultural research programs and in delineating the appropriate areas of responsibility of Federal and State agencies in carrying out these programs.

(2) To develop further the bases for State and Federal cooperation in planning and implementing regional and interstate research programs.

(3) To facilitate the coordination of plans for additional State and Federal research facilities to carry out the total effort of publicly-supported agricultural research.

(4) To stimulate selective interchange of Federal and State scientists to improve liaison and coordination between Federal and State research programs.

(5) To improve communications among Federal agricultural research agencies, the State stations, libraries, and information centers.

(6) To stimulate and foster training programs for promising young scientists so as to insure a continuing supply of well-trained manpower.

At its first session, the committee engaged in a thorough discussion of relations between Federal and State research agencies, with particular emphasis on problem areas. Five subcommittees were appointed, to concentrate on long-range planning, program development, facilities, scientific manpower, and financial resources. I am sure the subcommittee members will be consulting with many in this group as they tackle their assignments.

Additional steps have been taken recently to improve research coordination within the Department and with State and other research organizations.

A new Research Program Development and Evaluation Staff will provide an organized and continuing arrangement for Department-level research planning. It will service all advisory committees and maintain a Department-wide system of research project records. It will give leadership to work groups developing effective mechanisms both for evaluating current research and for planning new work.

In addition to the personnel who have previously been concerned with research coordination, the staff will include a team of five of our best scientists, who will devote full time to the improvement of program quality. We feel that this new office will increase our effectiveness in working with other Federal agencies, the Bureau of the Budget, and the Congress.

In a related action, we are planning to modernize the record-keeping procedures in the Central Project Office, one of the units now under the Research Program Development and Evaluation Staff.

Currently, the Central Project Office maintains detailed records on some 3,700 Department projects. The Cooperative State Research Service has similar records on some 6,700 State-supported projects and 6,400 projects financed wholly or in part by Federal funds.

We are considering the possibility of automating these records and locating them in one place. The improved system for record-keeping would provide a source of communication between scientists on all aspects of current research programs. And it would furnish comprehensive information to permit ready analysis of research for more effective management.

Other changes are taking place in the methods used in some of the research planning by the Department, and in the way we are administering some of our funds.

In planning research, we sometimes need to take an initial, broad look at the problem. Then, once the needs and objectives have been established -- without regard for agency lines -- the implementation will be agreed upon later among appropriate agencies of the Department and the States.

This unified approach is particularly appropriate when we are called, on short notice, to justify a research proposal to the Congress. On such occasions, we unfortunately may not have time for the usual formulation of plans within agencies of the Department or by the States, followed by review and coordination at agency and Departmental levels.

Our planning was across agency lines last summer when our request for supplemental funds for pesticide research and education was approved by the Bureau of the Budget. We first determined that our research needs lay in five areas -- biological and nonchemical pest-control methods, conventional pesticides that are more specific and less persistent, basic studies of the pests, the effects of pesticide use, and the economic facts about the use of pesticides. We also decided on the required educational program and library services. Then we determined who would do the work and what facilities would be required.

We have not had the natural mechanisms for this type of planning, and for the follow-up to insure that funds are used according to our proposals to the Congress. I hope that such planning will be facilitated by the changes in Departmental research coordination I have outlined.

In administering Federal research funds, we have awarded some money to State Experiment Stations on a competitive basis. Research under this method is somewhat more scientist-oriented than has been the case in the past. And funds are presumably concentrated in areas where the better scientists are located.

State interest in competitive grants is apparently great. In fiscal year 1964, when $1\frac{1}{2}$ million was assigned to the Cooperative State Research Service for awarding as grants, requests for over 350 projects were submitted. Our experience in handling these requests has led to a streamlining of procedures, changes that should save considerable time at both the State and Federal levels.

Because of our attempts during the past two years to obtain funds for competitive grants, one might get the impression that we are no longer interested in the time-tested system of formula grants. This certainly is not the case. We shall continue to press for a broad base of support for experiment stations throughout the country. We do not want to make the strong stronger and allow the weak to wither on the vine of non-support.

At the same time, we must not ignore trends and happenings which may suggest a supplementation of formula funds with support based on criteria other than population.

Among the trends we must consider are the following:

(1) Federal formula funds for the State Experiment Stations have not increased proportionately in the past few years, as compared to those allocated for the intramural program of the Department.

(2) There has been a tendency for the Congress to allocate funds for research on specific problems and at specific locations. Congress has allocated funds for this kind of work to the Department agencies.

(3) Federal funds for support of agricultural scientists from agencies other than the Department of Agriculture have greatly increased in recent years. Last year they were in excess of $24 million, about half as much as was received from Department sources. These funds are badly needed. The fact that they do not come from the USDA should not alter their value in support of scientists. At the same time, since they are almost completely scientist-oriented and controlled, they may be responsible for the setting up of an "elite" and a "second class" group of scientists in our Agricultural Experiment Stations. This can have serious consequences both for the Land-Grant Universities and for the Department.

We must take whatever steps we can to modify these trends or to make adjustments to them. Certainly, we need more basic formula support. We need to work out procedures to permit Experiment Stations to be funded by the Congress to carry out specific planned research assignments. And we must take steps to improve the prestige of agricultural scientists and graduate students at our universities.

The granting procedure on other than a formula basis is one that has been tried. It does permit the allocation of funds to a given State Experiment Station for a specific assignment. It permits project evaluation by scientists and gives credence to the competence of the man who is to do the job. At the same time, funds are allocated to the Experiment Station -- <u>not</u> to the scientist -- and we expect the Director to exert the same control over the work as he does currently over Hatch projects.

May I stress that the competitive grant is only one way of overcoming some of the problems of fund allocation to researchers at Land-Grant Universities. There are others -- and in cooperation with you, we intend to find them. The strength of agricultural research at Land-Grant Universities now determines to a considerable degree the strength of the Department's program in years to come. We must and will work together.

Another area of mutual concern is training and scientific environment for research and education personnel. Certainly, the ability to recruit and keep outstanding scientists is influenced by the professional stature of both the research administrators and their colleagues. And it is influenced by the intellectual and physical environment in which the scientists work.

A task force appointed by Secretary Freeman has just completed a study that spotlights the Department's strengths and weaknesses in these areas. The task force developed its recommendations after interviewing a representative sampling of USDA research personnel -- including young and mature scientists, at large and small research establishments, and in the major disciplines.

The study group was concerned with improving Federal-State relations in these recommendations:

First, that the Department develop closer cooperative relations with universities and colleges in order to increase opportunities for intellectual exchange.

Second, that continued emphasis be placed on moving scientists to locations providing better scientific environment. Specifically, that new research facilities be located on or near a university campus when the program permits.

Third, that the Department encourage its scientists to participate as members of graduate faculties of colleges and universities when such opportunities are available to them, and to accept, within practical limits, those teaching and counseling assignments that relate to their work.

Fourth, that a study and retraining leave program be established for those Department scientists who have demonstrated unusual scientific competence, and that opportunities be provided for scientists to take formal academic courses related to their field of work without reference to fulfilling the requirements of an advanced degree.

Fifth, that the Department obtain legislative authority to sponsor undergraduate, graduate, and postdoctoral scholarships, fellowships, and assistantships.

Sixth, that the Department determine its future needs for scientific personnel and work with appropriate colleges and universities in developing courses of study to meet those needs.

We intend to carry out these recommendations as rapidly as possible.

The Challenge of Change

So far, most of what I have said has concerned Federal-State relations in administering and coordinating research. Now I would like to turn to a subject that has primary application to our cooperative educational activities. This I am calling the challenge of change.

Undoubtedly the greatest challenge we face -- and one we must not fail to meet -- is in working with and for all people, without regard for the color of their skin or their national origin. Long-standing procedures and rules may need modification. Department policy, as you know, calls for prompt elimination of any discrimination in the operation of its programs and within its agencies.

Full compliance with the Civil Rights Act must begin with frank appraisal. It calls for full recognition of all failures to serve equally all segments of the population. It calls for a review of policies on hiring and promotion of personnel concerned with the Department's research and educational programs. I am confident a considerable amount of soul-searching has already been done.

I want to warn against two attitudes toward the speed with which the provisions of the Civil Rights Act are carried out. One is an attitude of resistance to any modification of the current method of operations. The other calls for making changes pellmell, without allowing time to develop workable procedures to get the job done. I hope we can avoid the pitfalls of both extremes. They are equally dangerous.

We in the Department are well aware that full and complete compliance cannot be accomplished overnight. But let me assure you we must not have unreasonable delays. Together we must make constant progress until it can truly be said that we have no racial discrimination in any of our research and education activities.

Along with improving its ability to work with all races, the Extension Service is also challenged to make other shifts of emphasis.

It is called upon to take the lead in developing the full potential of rural communities, and with improving the opportunities of the disadvantaged part of the rural population. And this must be accomplished without neglecting the obligations to commercial agriculture or the extremely important responsibilities to the consuming public.

Our cooperative Federal-State educational team has accepted a key role in Rural Areas Development. Extension took the leadership in organizing the development groups in 2,100 counties -- more than two-thirds of rural America. About 100,000 people are now participating on committees concerned with various phases of development.

We have a continuing obligation to help these groups follow through with their plans. They are depending upon us to stimulate ideas, to aid them in getting the services and resources needed, and to counsel them along the road to development.

And our experience with RAD has equipped us to accept new responsibilities in accomplishing the objectives of the Economic Opportunity Act. This national effort to alleviate poverty is directed almost equally at rural and urban America.

More than $1\frac{1}{2}$ million farm families have earnings, from all sources, totaling less than $3,000 a year. Few in this group can expect to become fully employed in farming or to obtain highly skilled employment -- because of the age of the farm operator or his lack of education.

This low-income group desperately needs educational assistance. These families should have help in deciding whether to stay on the farm or move to the city. Those who elect to stay on the farm require assistance in making the most of their opportunities, and those who decide to leave need help in adjusting to urban life.

Unfortunately, Extension often fails to reach low-income families. A recent study showed that Extension is serving only a third of those rural families whose incomes are $3,000 a year or less.

Adapting our methods to reach these families effectively will challenge our imagination and resourcefulness. But I am confident it will be done. Extension has a proud record of staying tuned to people's needs and adjusting its programs, methods, and competence as these needs have shifted.

May I make one other comment about Extension -- a comment that might be misunderstood in this day of competition between State and Federal agencies -- of the claims of State's Rights and of growing Federal Bureaucracy -- but a comment which I feel must be made. In my opinion, one of the best ways for the State Extension Services to help strengthen themselves is to strengthen the Federal Extension Service.

May I give an example? If an assignment, which normally falls in the area of responsibility of the Cooperative Extension Service, is given to the Federal Extension Service and if this assignment cannot be carried out for whatever the reason -- Extension throughout the country suffers. If the funds or personnel assigned to FES are inadequate to do this job, Extension suffers. And history tells us that the job will be reassigned to someone else.

During the coming year, I hope that we can study this problem and determine how we can make FES more effective in serving both you and the Department. We have some dedicated educators in this Agency, and they deserve all the support we can give them.

I am sure that the challenge of change will be met as we strive to improve all of our research and educational efforts. I suspect we will always have mutual problems. But we will conquer them if we continue the cooperative spirit that has marked our Federal-State partnership through the years.

# # #

PROTECTION AGAINST PESTS:

The Expanded Program of the U. S. Department of Agriculture and State Cooperators

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Talk by Dr. Nyle C. Brady
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U. S. Department of Agriculture
1965

PROTECTION AGAINST PESTS:

The Expanded Program of the U. S. Department of Agriculture and State Cooperators

Throughout the greater part of history, defense against pests has been a matter of "every man for himself." He has lacked the weapons and the organization for concerted attack against rodents, insects, weeds, animal and plant diseases, nematodes, parasites, and myriads of other pests. And, many a time, man has gone down in defeat. Pests have brought famines and plagues, and the pestilence that always accompanied wars in the past. Pests have helped to shape the history of the world.

As control methods improved, pests continued to be pretty much an individual worry. Only in comparatively recent years has protection against pests become a public responsibility.

SLIDE 1

It is now a matter of concern for the communities . . . the States . . . the Nation . . . and even the world.

The less-developed parts of the world can no longer provide enough food for the large numbers of people being born each year.

Within a very few years, a fantastic amount of food must be produced if mass starvation is to be averted. I believe the production of that food hinges more on efficient pest control than on any other single factor.

This is agriculture's job, but many national interests besides agriculture are involved in pest control.

About a third of the land in this Nation is Federally owned. Responsibility for controlling pests on this land and in U. S. installations all over the world rests with the Federal agencies concerned.

So does protection of the health and comfort of our people. Sanitation and freedom from pest-borne diseases require chemicals that can be used without themselves presenting hazards.

The Nation's water, its outdoor recreation areas, and other natural resources, including fish and wildlife, must also be protected against both pests and pesticides.

Efficient pest control is essential to national defense. Many of the materials that now protect civilian health and comfort against pests were developed first -- in agriculture and elsewhere -- to protect our military forces.

All these are Federal concerns, and usually State and local concerns as well.

The responsibilities of agriculture for protection against pests are basic and unique. Next to man's need to guard his own health and safety, his most pressing survival need is protection of his food, clothing, and shelter.

SLIDE 2

The policy of the U. S. Department of Agriculture in regard to pest control reflects the Department's dual concerns.

One is to "protect against pests" -- to develop control methods and materials and to facilitate their use against pests of man, animals, plants, farm and forest products, communities, and households.

USDA's other concern is to "control pests safely."

In providing protection against pests, the Department has vital concern for -- first -- the health and well-being of people who use pesticides and the products protected by their use, and -- second -- the protection of fish, wildlife, soil, air, and water from pesticide pollution.

The Department therefore uses -- and encourages others to use -- those means of effective pest control that are least hazardous potentially to man and animals. When residual pesticides must be used, they should be applied sparingly, precisely, and only as often as is absolutely necessary. The Department uses biological, ecological or cultural methods, or pesticides that are non-persistent and low in toxicity, whenever such means are practical, safe, and effective.

USDA commends its pesticides policy as a guide to the States and to local authorities.

In carrying out its dual objectives, the Department cooperates fully with the other agencies and departments of government.

Recently, concern for preventing unfavorable effects of pest control measures has been widespread. It has led to a complete airing of both the close-range and the potential problems in pesticide use.

SLIDE 3

Because of this concern, the Department requested the Congress to appropriate more funds to combat pests. USDA received an increase in its operating funds for the fiscal year 1965 of more than a third over the previous year. Other Federal Departments have also received increased support in this field.

USDA's new budget is a milestone, and how we spend it will determine our course for years ahead. As you can imagine, a great deal of scientific, administrative, and plain commonsense thinking has gone into the development of our plans.

Such an expanded program will require more personnel, and more room for them to work. At our request, the Congress has taken care of this by appropriating -- in addition to our expanded operating funds -- more than $5 million for planning or constructing new Federal and State facilities this year.

SLIDE 4

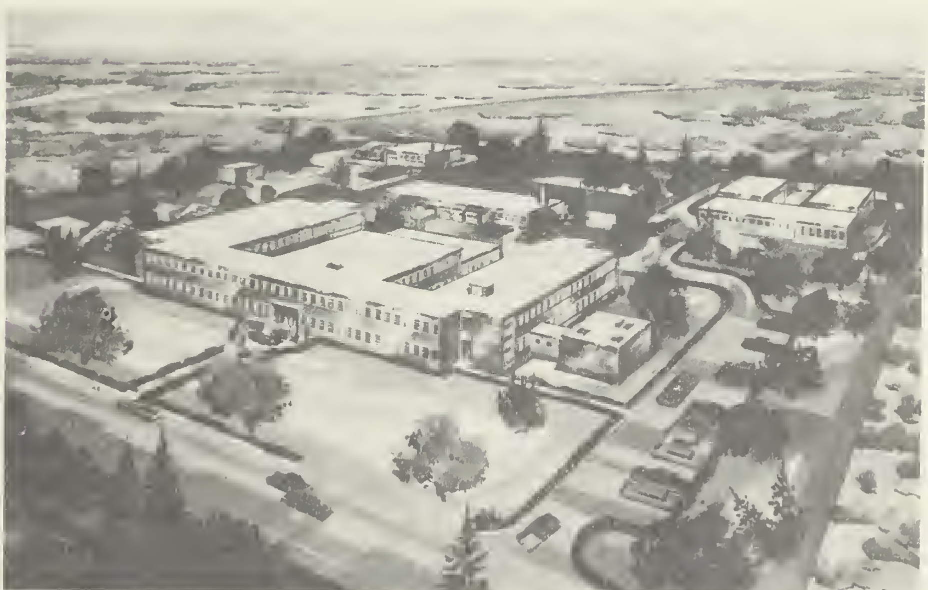
We hope they will be as attractive and efficient as the one shown here -- the Metabolism and Radiation Research Laboratory at Fargo, North Dakota, which is already in use.

The Department is asking for additional funds in 1966 to complete the new building program. If the funds are granted, USDA will have, in all, almost $14.5 million for 11 new laboratories, and the State experiment stations a total of at least $7.6 million in Federal and State funds to aid in construction of a number of their research facilities.

These funds for facilities are not included in the rest of our discussion.

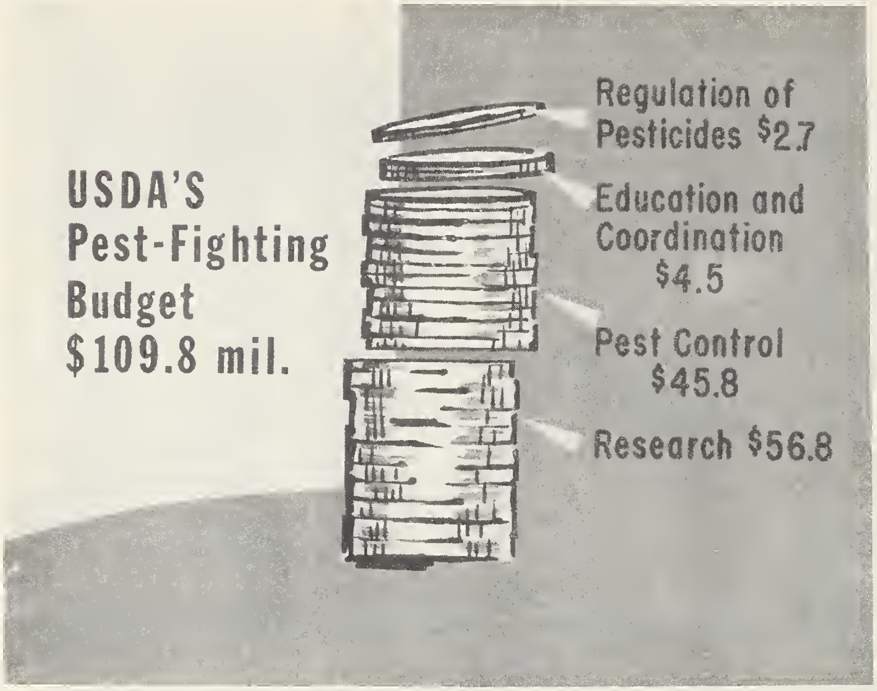
SLIDE 3

SLIDE 4



METABOLISM AND RADIATION LABORATORY FARGO, NORTH DAKOTA
HAROLD E BECHTEL · ARCHITECT

GENERAL SERVICES ADMINISTRATION
PUBLIC BUILDINGS SERVICE WASHINGTON, D.C.



SLIDE 5

Now let's see how USDA spends its 1965 operating funds to fight pests.

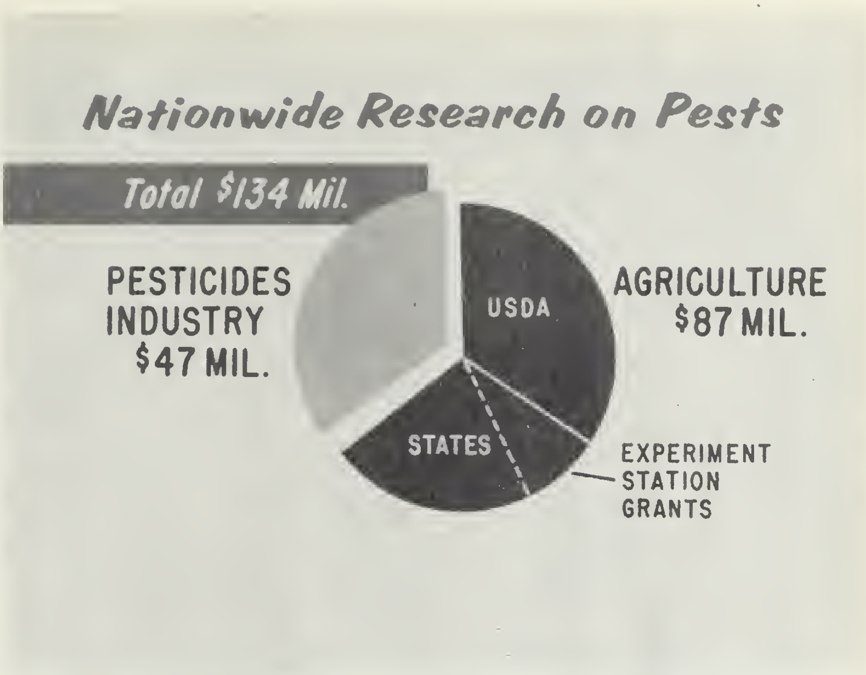
Of the total $109.8 million, almost $14.5 million, or more than 13 percent, goes directly to the States for work in their agricultural experiment stations and extension services.

Here you see the areas in which the money is spent . . . 2 percent for regulation of pesticides, 4 percent for education and coordination, 42 percent for pest control, and more than half -- 52 percent -- for research. This is the area where we expect the greatest returns in developing better pest control methods.

So let's discuss research first.

Before I go into detail about the Department's expanded research program, however, I want to put it into perspective in a larger framework.

Agricultural research in the United States is usually a joint effort of public and private agencies, and research on controlling pests is no exception.



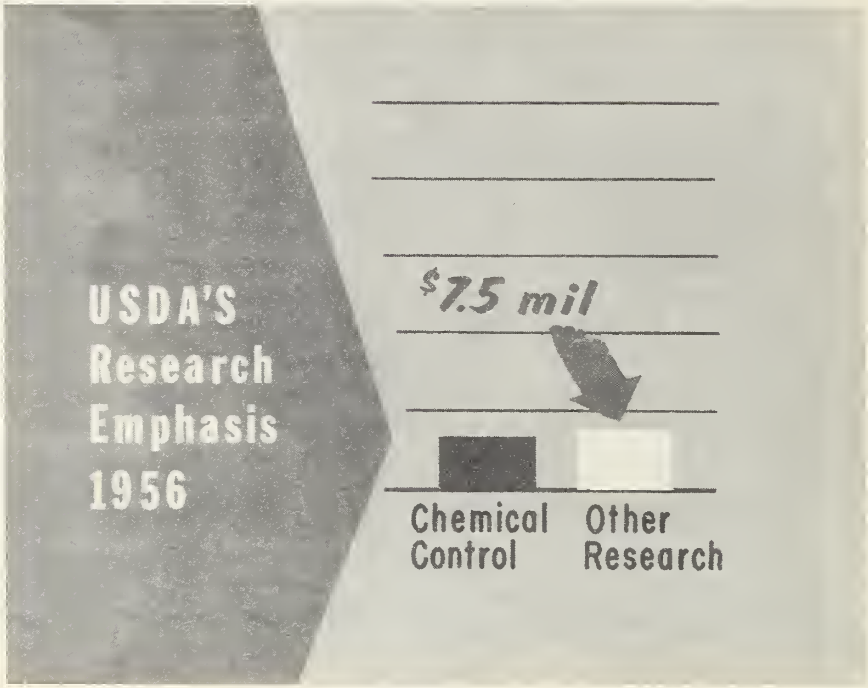
SLIDE 6

Here is a rough estimate of what agriculture and the pesticides industry are spending in 1965 on pest-control research. Some additional work in this field is also carried on by a few public agencies other than Agriculture. And if the industry figure were to include research and development costs for equipment for applying pesticides, for the hormones, feed additives, and other veterinary biologics and drugs that might cause residues in meats, and so on, our scientists figure it would be closer to $100 million a year.

Congress provides almost $47 million for USDA research and more than $10 million for the State experiment stations in the Federal grants that USDA administers. We estimate that the States provide about $30 million, which also includes funds made available to the State experiment stations by industry, private foundations, and grants from Federal agencies other than Agriculture.

The past decade has witnessed a great shift in interest and emphasis in pest control research . . . a shift to intensified research on controlling pests without the use of conventional pesticides.

I want to show you how USDA research reflects this change in emphasis.



SLIDE 7

In 1956, research on chemical means of controlling pests amounted to almost as much as all our other research on pest control put together.

SLIDE 8

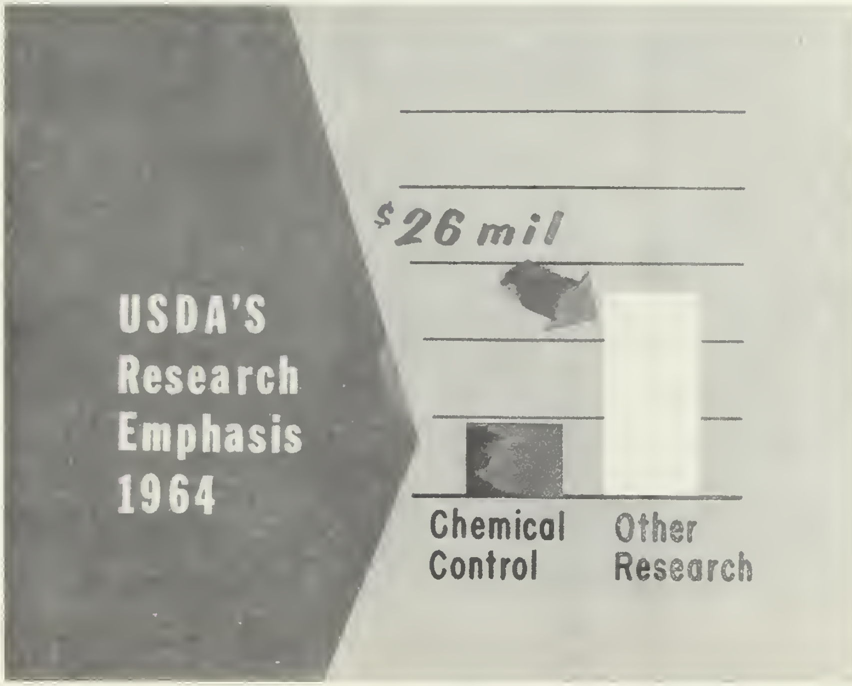
Funds for research on <u>chemical</u> controls increased only moderately over the years. The big increases went into other research. By 1964, funds for research on developing other means of control were almost three times the amount allotted for chemical controls.

SLIDE 9

And when the 1965 breakthrough in the budget came along, nearly all the increase went into research for controls other than chemicals.

Now let's see how USDA spends its research money in this field.

SLIDE 8



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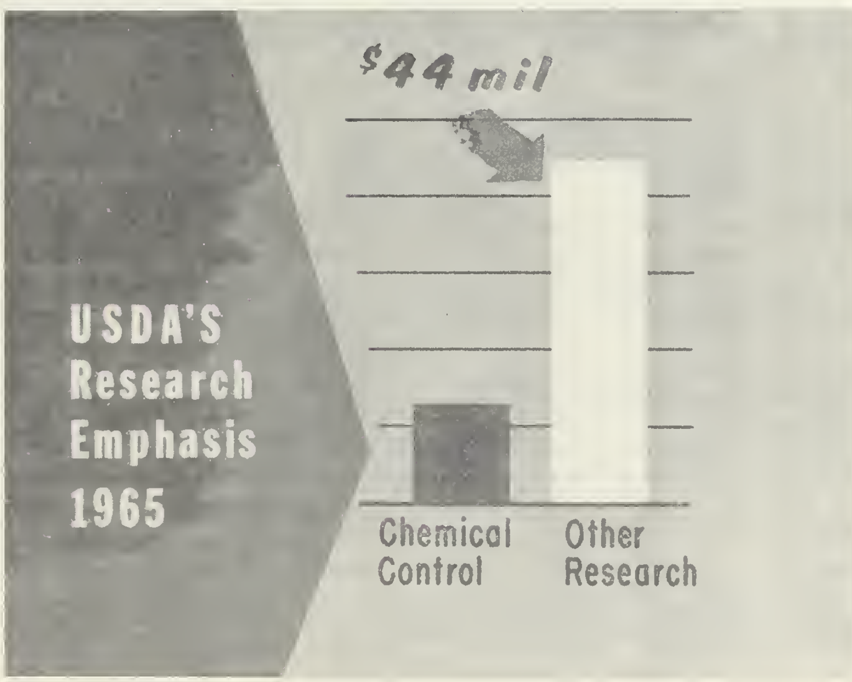
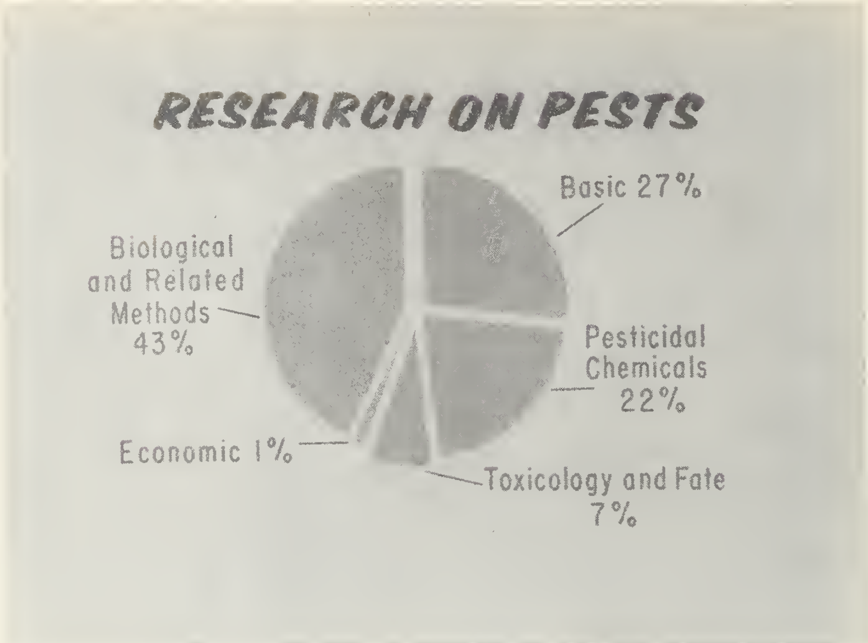




SLIDE 10

The largest single portion of the money we are spending on research -- 43 percent -- is going for research on biological and related means of control. Natural enemies and pest-resistant crops are among our oldest weapons against pests. We also have much to gain from research on ways to sterilize and use pests for their own destruction, on sex and food attractants, on repellants, on new means of weed control, and on the use of light, electricity, and sound for controlling pests of all kinds.

Basic research takes the next biggest chunk -- 27 percent -- of our money. In all of the research areas I've mentioned, we are seriously handicapped because we lack fundamental knowledge about the organisms and materials we are dealing with. Future discoveries about the genetics, cells, nutrition, viruses, proteins, or enzymes of animals, plants, or pests may furnish keys to new methods of control that are beyond our imagination now.

By exploring the metabolism of pesticides and related materials in insects, plants, and animals, we hope to develop pesticides that are highly selective in their action against a pest without creating harm to plants or animals.

As a service to those engaged in basic and other research, we established a Pesticides Information Center this year as part of the USDA's National Agricultural Library. It employs a new weapon against pests -- the computer -- to help scientists, administrators, and other workers keep abreast of the flood of scientific and technical information being published on pests and their control.

More than 22 percent of our research budget is being spent in developing new and better techniques of using pesticidal chemicals effectively and safely. For example, in one test, a combination of insecticide and sex attractant eradicated the oriental fruit fly from the 33-square-mile island of Rota, in the Pacific.

We're spending 7 percent of our money for research on the toxicology and fate of pesticides. Everyone recognizes the need for research in this field. The public is entitled to sound, scientific judgments on the effects of pesticides. Research can provide us with the impartial data that are needed to make these judgments.

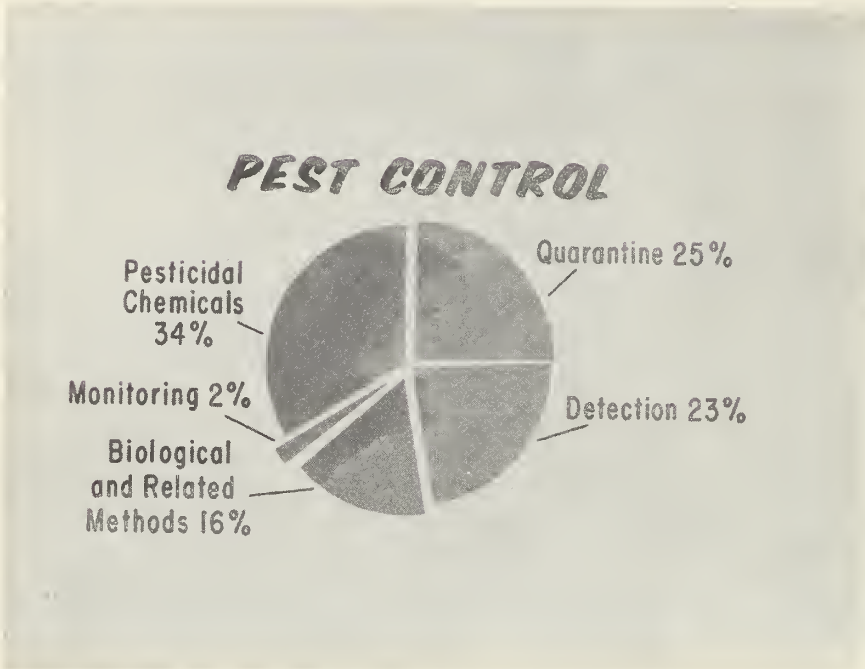
One percent goes to research to determine the economic effects of the pests and to evaluate the comparative economics of various means of pest control.

Our most telling means of pest control in the future will probably combine research from all these fields into integrated, custom-made programs that attack each pest at its most vulnerable points.

Internationally, USDA scientists, like State scientists, cooperate constantly with other countries, both formally and informally. Exchanges of scientists . . . international conferences . . . work with the Agency for International Development, with the private foundations, and with the World Health and Food and Agriculture Organizations of the United Nations -- all these add a steadily expanding dimension to our work against pests.

I'd also like to mention here the foreign research on pests that is being done for us under Public Law 480 grants. Since 1959, the equivalent -- in foreign currency -- of almost 4 million dollars has gone into such research. Sales of U. S. food to the countries concerned pay for it -- it does not come out of our regular budgets.

The research must be useful to the country concerned and to ours. It is of particular value to us in furnishing information on pests we do not have -- yet -- and on the natural enemies some of our foreign pests left behind them.



SLIDE 11

Now, what about the money we spend on <u>control programs</u>? It breaks down like this.

Thirty-four percent of this money is spent on control work using pesticidal chemicals in accordance with the USDA policy we talked about earlier.

Twenty-five percent of our control funds go to quarantine work. This pays for inspectors who are stationed at our ports and borders to prevent the introduction of foreign pests into this country. It's the ounce-of-prevention theory, and it has paid off for us many times in the past.

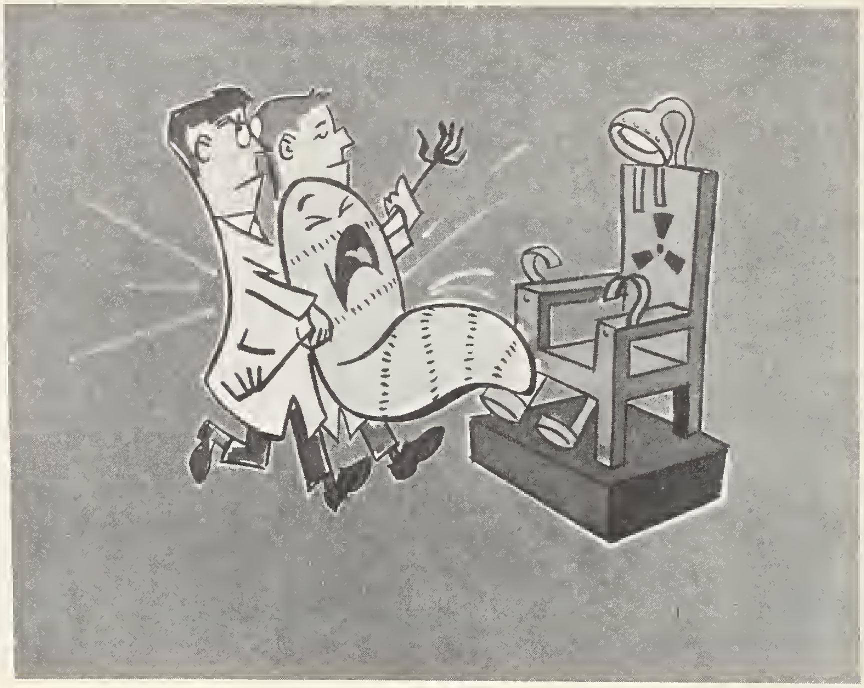
Similarly, cooperative control programs within the country are supported by Federal and State quarantine measures. These quarantines slow or prevent the spread of pests into uninfested areas, and reduce the need for any kind of treatment.

Twenty-three percent of our money in control programs is spent in improving our control techniques and in detection work. Surveys determine the presence or extent of infestations, and whether control measures should be undertaken. This work tells us how effective our control programs are at any given time and helps us move quickly to keep outbreaks from becoming epidemics.

Our monitoring and program evaluation work takes 2 percent of our budget in control work and is probably as important a 2 percent as any other we're spending. We are keeping an eye on the various components of the environment by sampling and analyzing water, soil, crops, and various organisms for pesticides. We're monitoring all our own control programs, and we're also monitoring representative areas of the country where large quantities of pesticides are used in normal farming operations. This new work will give us much valuable information on the impact of pesticides on man's total environment.

Biological and related methods of control account for 16 percent of our control funds. This proportion is bound to increase as our new efforts in both biological and basic research begin to pay off.

One of the most dramatic and successful methods of controlling pests without the use of chemicals is the application of the sterility principle. It has already rid the United States of overwintering populations of screwworms -- costly livestock pests -- as far west as Arizona.



SLIDE 12

Screwworms are reared at Mission, Texas, in the world's largest insect nursery. When they become pupae, they are exposed to cobalt 60. The gamma rays destroy their ability to reproduce.

SLIDE 13

The adult, sterile flies are air-dropped by the millions over screwworm-infested areas. Each male mating with a native female fly renders her eggs infertile. The "fly factory" is now providing sterile flies for a wide, living barrier to the south, to protect the United States from reinfestation.

These, then, are the ways our control money is being spent.

SLIDE 14

In addition, we are responsible for the regulation of all pesticides marketed in interstate commerce. Nearly half of the money for this work is used for registration activities, and 45 percent for enforcement. Examples of recent progress include new requirements so that key warning and caution statements on labels are more prominent, legible, and understandable. And precautionary labeling is also now required for the protection of fish and wildlife.

USDA inspectors regularly sample both meat and poultry for biological residues. Of the funds shown here, about 7 percent goes into this work.

SLIDE 15

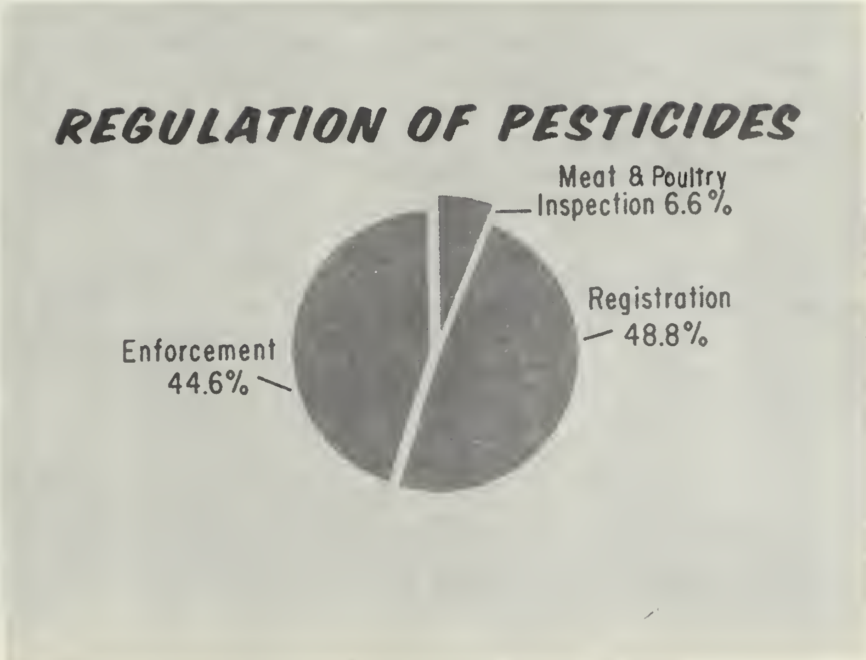
The final area of activities -- education and coordination -- gets 4 percent of USDA's operating funds. The States more than match Federal funds for extension education in this field.

The Department and Cooperative Extension Services throughout the country have been engaged in one of the greatest educational efforts in their history. In the past two years alone, we have distributed millions of copies of safe-use literature to city dwellers and farmers. Our radio and television efforts on pesticide safety have been endorsed by the Advertising Council, and we are getting excellent exposure. Newspapers, magazines, and picture syndicates are carrying our messages on pesticide safety. And the National Safety Council, civic organizations, and the chemical industry are cooperating with us.

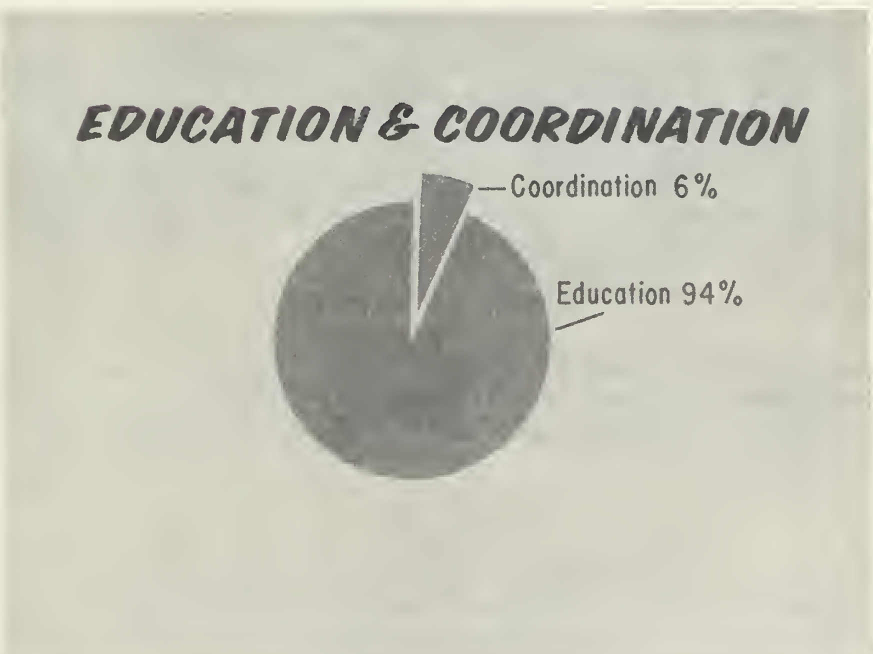
In nearly all the States, a Pesticide Chemicals Coordinator has been appointed by the Extension Services. He serves as a focal point for an intensified education program.

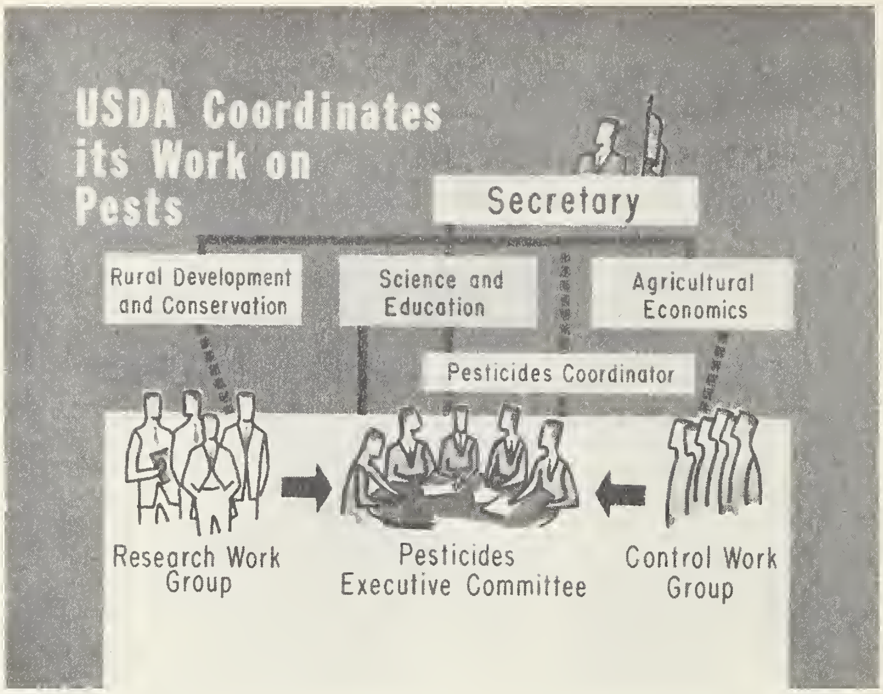
I hope this review has indicated the broad range of Federal involvement in protection against pests . . . the many disciplines that are at work . . . and the numerous agencies and interests to be considered. It is this sweeping coverage that makes coordination imperative if the work of these agencies and these people is to be fully effective.

SLIDE 14



SLIDE 15





SLIDE 16

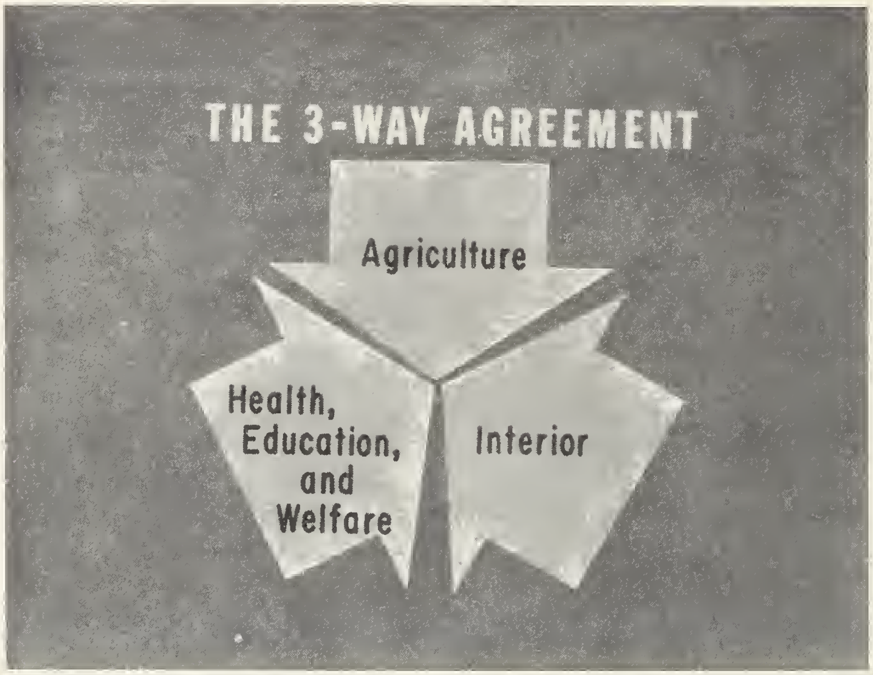
Here's how USDA coordinates its own work on pests. Several areas of interest are involved -- Rural Development and Conservation, Science and Education, and Agricultural Economics. These interests are represented in Work Groups on Pesticides Research and Pesticides Control and on the Executive Committee on Pesticides we recently established. The Committee keeps abreast of all current activities on pesticides and recommends studies and programs to the two Work Groups.

A small staff headed by a scientist with the title of Pesticides Coordinator has been established in the Office of the Secretary. The staff is directly responsible to me as Director of Science and Education.

Here, too, is the framework for coordinating our work with <u>other</u> Departments. Our Coordinator and his counterparts in other Departments serve as an overall mechanism, and the Work Groups and the Committee provide effective liaison.

SLIDE 17

The Secretary of Agriculture helped to establish the Federal Committee on Pest Control, which was organized by the joint efforts of the Secretaries of Agriculture, Defense, Health, Education, and Welfare (HEW), and Interior. It reviews Federal pest control programs to assure that the methods to be used are effective and safe.



SLIDE 18

These three Departments -- Agriculture, HEW, and Interior -- have made an Agreement to maintain liaison on all programs involving pests, pesticides, and pest control, and particularly on pesticide registration. They are planning a national symposium on pesticides for this fall. Also, work conferences will bring together Federal and State specialists in research, regulation, and information.

The three Departments are supporting the organization of State Pest Control Councils to review and evaluate State programs relating to pests.

At the request of the Departments of Agriculture and HEW, the National Academy of Sciences -- scientific adviser to the Federal Government -- has reexamined the question of "zero tolerance" and "no residue." Pesticide residues on or in foods can now be detected in infinitesimal amounts. The Academy has proposed a more realistic approach to this situation, and the Departments are now considering its recommendations.

Other Academy studies are being developed to inquire into such matters as the effects of agricultural use of pesticides on wildlife, and to develop a series of manuals on the principles of pest control.

These, then, are the ways USDA is expanding its efforts to protect agriculture, man, and his environment against pests.

In the future, as nations coordinate their activities against pests more closely

. . . as the fine cooperation between the Federal services and the States continues and grows

. . . as expanded programs quicken our progress in research, regulation, and education

. . . and as individuals use sophisticated pest-control weapons with increased knowledge and care

. . . I am confident that we can look forward to more -- and more decisive -- victories in the unending war against pests.

THE FUTURE OF AGRICULTURAL RESEARCH

Talk by Dr. Nyle C. Brady, Director, Science and Education, U. S. Department of Agriculture, at dedication ceremony of Harry L. Russell Laboratory, as part of annual Agricultural Industries Conference and Public Affairs Forum, University of Wisconsin, Madison, Jan. 28, 1965.

No-one can speak with confidence and precision about the future of agricultural research. All that one can do is to show the distance we have already travelled, and point to the probable directions we will be taking.

This is what I propose to do today.

You have asked me to stress the bilogical sciences. This will not be difficult, since the major share of research in agriculture deals with biological organisms.

Before we take our excursion into the future, let us look back a moment or two to see what has been happening to agricultural research.

About a hundred years ago, when publicly supported agricultural research had its major beginnings, the objectives were modest and the work was relatively uncomplicated. There was little basic research and little understanding or appreciation of its methods and purposes.

It seemed natural to assume, as most people did, that basic scientific concepts should be imported from Europe. There was little time for the lengthy, intensive studies characteristic of basic research. Scientists were much too busy dealing with the practical, day-to-day problems of farming that were proliferating on all sides.

Neither the public nor the Congress showed any special interest in the growing research activities of the States or the U. S. Department of Agriculture.

In time, basic studies came to be recognized generally as fundamental to significant improvements in agriculture as elsewhere, and research itself was recognized as a national resource. There developed a trend toward more basic studies and more comprehensive research programs.

Starting with the Bankhead-Jones Act of 1935 we have steadily increased our emphasis on basic research. Today, close to 35 percent of the research conducted by the State experiment stations is basic, compared to 20 percent 15 years ago. Nearly 32 percent of the Department's studies are basic, compared to 13 percent 15 years ago. We expect to increase the proportion of our studies devoted to basic work steadily. This is possible because industry is assuming more of the responsibilities of the applied work that we have been carrying on through the years.

There is widespread support for agricultural research not only by industry, but also by a growing segment of the American public.

The public has largely lost the "show me today" attitude it once had about research -- that attitude that says results must be forthcoming right away and must be of direct and visible practical use or they are of no use at all. Most people recognize that research does indeed benefit mankind . . . and that even the most improbable basic work is eventually utilized in some way to make life more satisfying. Also more perplexing -- but that is another story. Research has been so successful, in fact, that there appears at times almost a frightening dependence upon the scientists to solve some of the critical problems of the world.

Agricultural research is also gaining support from "outside sources" - from agencies that are doing work similar to ours or are interested in such work for reasons of their own.

These include the National Science Foundation, the National Aeronautics and Space Administration, the Department of Defense, the National Institutes of Health, and the Atomic Energy Commission.

As our Government gets more deeply into medical, space, and defense programs involving biological forms of life, that support will undoubtedly continue to expand in the years ahead.

Now, what about the years ahead for agricultural research? In which areas of the biological sciences can we expect major contributions? Can we foresee some of the results of these contributions? Are we willing as scientists to accept the responsibilities for these contributions and guide them into socially acceptable channels?

Some of these questions we can answer more readily than others, although all of them eventually will require answers of one sort or another.

To begin with, we can predict reasonably well the areas of biological research that hold special promise for agriculture.

These include:

1. Creating deliberate genetic changes in biological organisms and determining the implications of such changes.

2. Controlling diseases in plants and animals.

3. Discovering how living plants function.

4. Improving our knowledge of nutrition.

5. Developing safe and effective means of controlling pests.

Other areas of the biological sciences are certainly important. But these seem to me to be the most significant in terms of their potential effects upon agriculture.

In terms of directed genetic change, we shall probably be dealing in the future with modified forms of the same types of plants and animals that exist now. Surprisingly few new species have been introduced for use over the past several centuries. Success has been achieved primarily with strains and hybrids of existing species. This pattern of genetic development will probably continue for at least some time to come.

The key to genetic properties lies in the nucleic acids, which are long-chain molecules that carry the genetic information for the cell and the organism. In very simple terms, most of the differences among people, plants, animals, and all other living organisms result from differences in the number and sequence of the units -- the nucleotides -- in their nucleic acid.

Scientists have isolated nucleic acids from viruses and treated them with nitrous acid. The result was a change in the sequence of the nucleotides, with accompanying changes in disease symptoms. The questions now are -- what change in nucleotide sequence can cause a particular mutation? Will we be able to control such change? Would it then be possible to change a specific plant or animal to make it more resistant to disease, or to make it a better food? Could we control the metabolic processes of the seed sufficiently so it would form large amounts of a desired protein?

Although at the present time only random uncontrolled changes can be made, it is interesting to speculate that such control over nucleotides to form desired mutations might be possible. An intensive study of molecular genetics -- the chemical, physical, and biological properties of nucleic acids -- is essential. We are moving ahead in this field. The coding of genetic information is gradually being unravelled in laboratories in this country and throughout the world.

From a somewhat more practical standpoint, there is much that can be done to take advantage of the tremendous existing genetic variability in breeding animals. Artificial insemination as a method of extending the use of desirable selections is highly developed and will continue to be important. Similarly, artificial implantation of desirable fertilized eggs is developing.

Books have been written about the implications of altering the genetic structure of living matter. So far, of course, animals and plants have been bred with a view to increasing a particular productive trait. And this has been largely successful. How far can we go, though, in bringing about changes of a more radical nature? Almost as far as we wish to go, apparently, according to the geneticists. The decision is one we will have to make some day. It is one that will require much more knowledge and wisdom than we have today.

Attempts to control diseases of plants and animals constitute one of our major and costliest efforts in agricultural research. Up until very recently, we have had to deal with disease problems as they have arisen, and have not been able to invest the necessary effort to understand the basic concepts of disease control.

I have mentioned the fact that genetic information is infinitely variable. This fact underlies all our efforts in the long struggle to obtain disease resistance. It seems to be in the nature of things that an organism or virus invading a plant undergoes genetic modification for its effectiveness as the character of the plant is changed . . . or it can suddenly appear as a new virulent strain.

For example, we still have the rusts and the smuts of cereals and the respiratory diseases of livestock. We keep them under control and do not go hungry because of the damage they inflict. But we still have them.

In an effort to gain some insight into the problems associated with virus diseases, our scientists are developing a fund of information on what happens when a virus gets into a cell. They have stripped away the protein shell from around the nucleic acid of virus particles, and found that the nucleic acid was only mildly infective. When the protein shell was placed back on the nucleic acid, the degree of infectivity was increased to 80 percent that of the untreated control. Perhaps the host enzymes remove the protein shell. Then the nucleic acid probably attaches itself to some structure within the cell and in some way dictates the production of many replicas of itself, of the proteins required for the protecting shell, and the enzymes to help put the shell on.

In some extremely interesting work at the Carnegie Institute of Washington and elsewhere, scientists have found a 20 percent similarity in nucleic acids among monkeys, mice, and men. This suggests a common ancestry. And, if man needs to be reminded, it points to an irreducible mutuality among all the mammals.

One of our scientists has made a major contribution in the field of host-parasite relationship by showing that it is possible to immunize some forms of life -- chickens, in this case -- against cancerous diseases. Another has been able to immunize chickens against coccidia organisms. Still another has purified the foot-and-mouth disease virus, improving our abilities to refine and use vaccines to immunize cattle against the disease.

Some interesting and significant basic studies on blood antigens and antibodies are revealing relationships that are of special interest in the field of immunology. Leading this work, by the way, is Dr. Sam L. Scheinberg, who received his Ph.D. here at the University of Wisconsin and who was a post-doctoral fellow here for several years.

In projecting the results of specific biological research in animal diseases, we may expect major advances in treating virus diseases . . . eradication of cattle scab and sheep scabies . . . a cure for coccidiosis. The direct, indirect, and predisposing causes of animal tumors and cancers will be better understood. Laboratory animals free of specific germs and viruses will be more readily available to commercial biological laboratories for accelerating disease studies. Research on animal diseases and parasites will be conducted with far better methods than we have today and with the widest range of equipment, much of it borrowed from nuclear science.

Nature is fluid and forever variable. We will probably not eliminate disease as a cause of death or unthriftiness in the near future -- at least not with our present knowledge.

Probably no other aspect of agriculture has caught the imagination of people as much as that of <u>discovering how living plants function</u>. Progress has been made in this area by studying the light response of plants.

You may know that our scientists have succeeded in isolating phytochrome from plants. This is the bluish-green chemical substance that in active form controls the germination of seeds, elongation of stems, flowering of plants, and probably many other things that haven't yet been discovered. It is involved in growth and development of all plants, at least all those above the algae.

It is difficult to study a plant in a living environment and extract the many variable factors involved in finding out how it functions. Using light as a tool, however, we can reach into the plant and disentangle some of these factors. Phytochrome, which we believe may be an enzyme, apparently triggers the varying response of the plant to various kinds of light used at various times.

We would like to understand more fully how phytochrome functions and how it interacts with light to bring about changes in the plant.

With such knowledge, we will be in a position to learn more about the action of herbicides within a plant . . . whether or not they are equally effective, for example, when applied at the vegetative and flowering stages. And in inoculating plants with viruses to control pests or diseases, does the condition of the plant make any difference? Could we find out how a disease gets a foothold in the plant?

I believe these are problems that can be worked out as we learn more about the interaction of light and plant life.

One could go on almost indefinitely listing the possibilities for biological studies in this field.

The whole problem of micro-environment -- the relationship between the plant and the soil, water, and air -- is important. For example, on the carbon dioxide problem -- what are the ground rules for transportation of carbon dioxide to the plant? Work by Department and Cornell scientists suggests that air turbulence is a factor. The turbulent action of the air brings the carbon dioxide from the atmosphere into contact with the plant. On a hot, still day when there is little wind, less carbon dioxide is available to the plant, and the rate of growth seems to slow down. Carbon dioxide may be the factor that limits the growth. The geometric structure of the plant is involved in generating and altering turbulence, although how we cannot say.

Man's greatest challenge in the next 25 years is to provide food for our exploding populations. Understanding of the basic food manufacturing process -- photosynthesis -- is our first step in feeding the hungry millions that demographers have predicted. We must increase the efficiency of utilizing the sun's energy or look to other non-biological means of providing food.

The uptake of ions into plant tissues and their transport across plant membranes is another area of importance. So is the work on finding ways to improve the efficiency with which plants use water. If ways could be found to control even a small part of the water loss from plants, it might be possible to grow crops under more arid conditions, thus opening up vast areas for agriculture which are now considered unsuitable. The results in terms of adding to the world food supply are obvious.

Moving from plants to animals, we recognize that environmental factors can seriously affect livestock production by creating stresses that we do not thoroughly understand. This is particularly important as larger numbers of livestock are confined to smaller areas. We have to know more about the effects of the environment in order to control the many variable factors that enter into our continuously refined studies on livestock production.

Scientists have recently been investigating the "cold north sky" concept, which may help alleviate heat stress in cattle. Certain areas of the northern sky were found to be colder than others. Animals can radiate heat to these areas -- thereby reducing their heat stress -- even though the air temperature may be as high as the body temperature of the animals.

In cold weather, feed efficiency decreases as animals eat more to keep warm. It may be more economical to provide a source of heat rather than to allow the animals to burn their own fuel in the form of additional feed.

A knowledge of the way in which animals and plants respond to the environment in which they grow is certainly basic to progress in agriculture, particularly for the future.

In our gradual emergence from an extensive to an intensive agriculture, we are increasingly concerned about improving our knowledge of nutrition.

Food is the fuel for life -- for plants and animals and man. And great as are the differences among these forms of life, their pathways of metabolism are essentially very much alike.

Application of new nutrition information has helped to bring about increased efficiency in broiler production and a plentiful supply at low prices, as any housewife can tell you. We need to develop and apply nutritional data for livestock as well.

Future sources of nutrients, for example, may include such things as sea and ocean water as a source of minerals; algae to furnish protein and other essential nutritional factors; molds as a source of estrogenic substances; microbial and bacterial organisms for synthesizing agents for protein and vitamins.

They assume greater significance when one considers the growing trends away from cattle production on grasslands toward production in confinement or semi-confinement. There seems little doubt that this trend will continue as grasslands are utilized for other more immediately productive purposes.

Perhaps the one factor that has the greatest potential for meeting the needs of agriculture in the future is expanded production of nitrogen. We now produce nitrogen compounds at the rate of 5 million tons per year, thus augmenting the activity of plants in forming nitrogen many times over again. We have learned a great deal about the nitrogen fixation process by plants. There is always the hope that perhaps we could make all plants effective large-scale producers of nitrogen for commercial purposes. This, of course, would revolutionize agriculture, and would make possible vastly increased production of food throughout the world.

There is much that the biological sciences can contribute to the full development of safe and effective growth hormones, and to a knowledge of vitamin and mineral activity in the metabolic pathways. Trace minerals are increasingly important. We need to clarify the relationships between the function of selenium and muscular disorders and other similar kinds of relationships as yet unknown. The use of one element affects another, and various combinations of elements must be considered as a whole.

Contributions to the study of human nutrition are almost endless. Among the most important problems are how to prolong the useful span of human life and how to avoid the cardiovascular changes that seem in some way to be related to intake of certain kinds of fats. The biosynthesis of cholesterol has only recently been clarified -- a discovery that brought its discoverers the Nobel prize. This work is basic to an understanding of arterioschlerosis and to all questions relating to synthesis and degradation of fats.

One of the newer areas for fruitful biological research lies in developing safe and effective means of controlling pests.

I am sure you are aware of the problems we face in using pesticides today. We could not continue our present level of agricultural production without them. Yet, in using them, we are facing increasingly serious problems of residues and possible environmental contamination. We are investigating a wide range of techniques which do not utilize chemicals, or use only minimal amounts.

Chemosterilants -- used along with natural or synthetic insect attractants -- look very promising. The attractants serve to lure the insect to a place where the chemosterilant can then sterilize it. These chemosterilants must be used with the greatest caution, however, so there will be no danger of contaminating the environment.

Natural control techniques are also promising. We can use natural enemies such as parasites and predators or pathogens such as bacteria, fungi, protozoa, and viruses. We can alter the genetic characteristics of the unwanted pests. Or we can prevent seed or pollen production of the unwanted plant.

But we know that even bacteria can sometimes produce toxic effects. Bacillus thuringiensis, for example, has been used to control several insects. It contains at least two known toxicants, however, and must be used with great care. Viruses, as I mentioned earlier, change constantly, and we must be alert to the possibilities of undesirable and hazardous changes.

My point is that even in using natural or biological techniques for controlling pests, our problems are not over. We still face many difficulties and will undoubtedly face many more as these techniques are used on a practical basis over extended periods of time.

Of course, we are studying and developing many other methods for controlling pests, including improved chemicals, breeding resistance into plants and animals, mechanical techniques, light in various forms, and cultural techniques.

I want to point out that the things I have been talking about so far are not quite so lucid as I have made them sound. The disciplines making up agricultural research are deeply inter-related, and even to discuss them under separate headings unwittingly gives a false impression of tidiness and precision of structure which is not entirely correct. Problems that need solutions do not neatly categorize themselves into a special area of study. They frequently reach across a dozen or more disciplines. Each adds its share of knowledge, like the pieces of a jigsaw puzzle, to make up a total solution.

Many new patterns are emerging in science today and not all of them are entirely favorable, in my opinion. Foremost is the attempt to structure science into areas of increasing specialization with its steadily mounting costs and inevitable huge organizations. Bigness invariably brings a preoccupation with efficiency at any cost and a scramble for funds to support the ever-expanding superlaboratories. The British astronomer, Fred Hoyle, deplores this tendency toward what he calls the "dinosaur mentality" in science, and the submergence of inspiration in the search for ever-increasing efficiency.

It is big ideas -- not big science -- that bring about great and lasting discoveries. The scientific spirit is fundamentally contemplative and calls for understanding based on insight, and insight cannot be forced by collective action.

I want to remind you, in Hoyle's own words, that " . . . it seems to be characteristic of all great work, in every field, that it arises spontaneously and unpretentiously, and that its creators wear a cloak of imprecision . . . the man who voyages strange seas must of necessity be a little unsure of himself. It is the man with the flashy air of knowing everything, who is always on the ball, always with it, that we should beware of. It will not be very long now before his behavior can be imitated quite perfectly by a computer."

While we recognize the inevitability and necessity for some of these new cultural patterns in science, we can prevent them from going to extremes.

For example, we can guard against separation of the biological sciences into separate research structures. The biologists are an integral part of their department research teams and are more effective when they can work directly with the basic problem rather than with isolated portions of it. The biologists do not profit by such isolation and the departments from which they are pulled suffer by their removal. We ought to encourage, as much as possible, a movement <u>away</u> from intense specialization and <u>toward</u> an inter-mixing of scientists performing broadly based studies.

Here in Wisconsin, you have gotten away at least partially from this kind of structuring, and your basic biologists are still located where they will perform most capably -- in the subject-matter departments. I believe that these subject-matter departments -- in university, State, and Federal laboratories -- must continue to be a main source of strength.